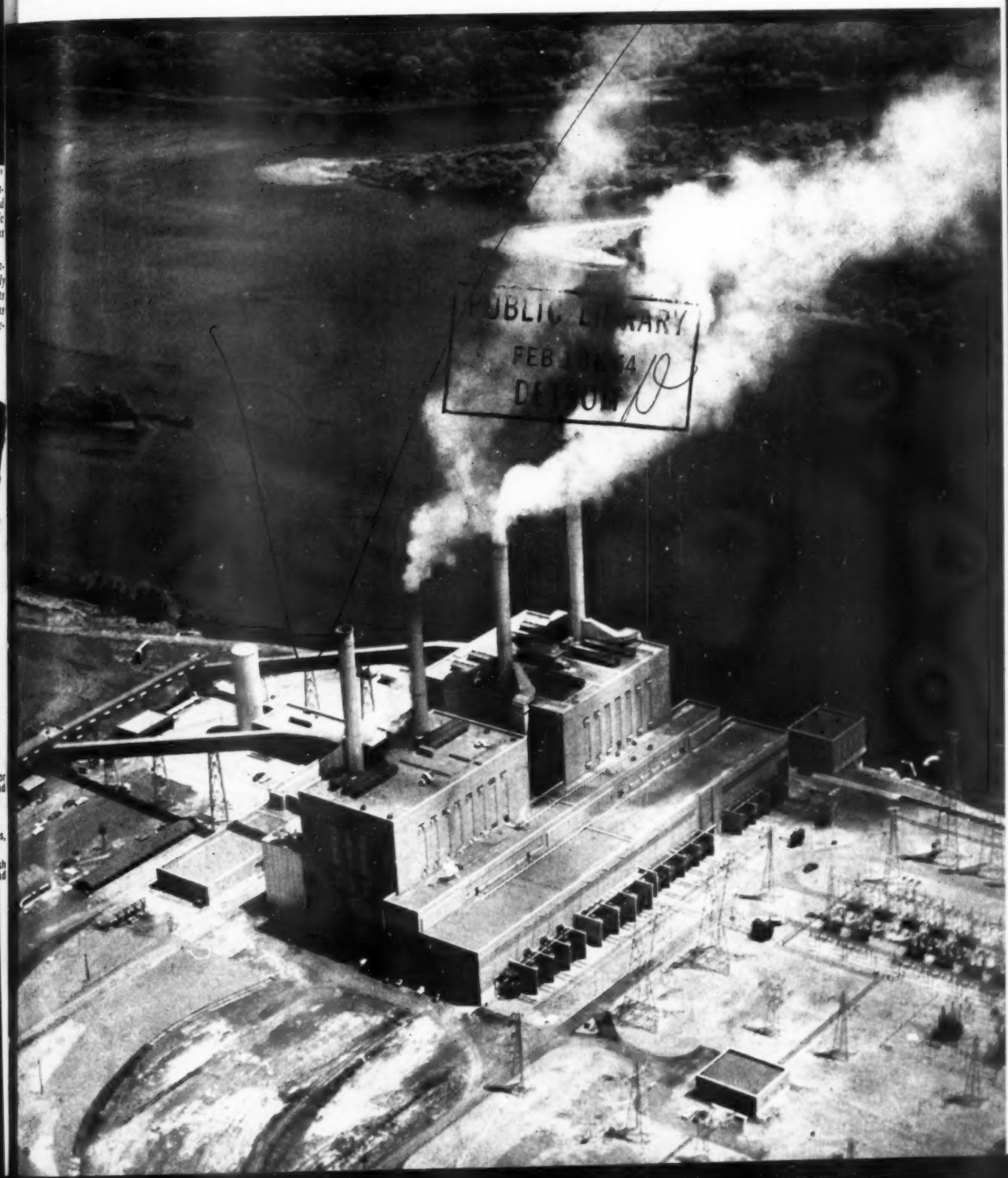
TECHNOLOGY DEPT.

TECHNOLOGY REVIEW

February 1955



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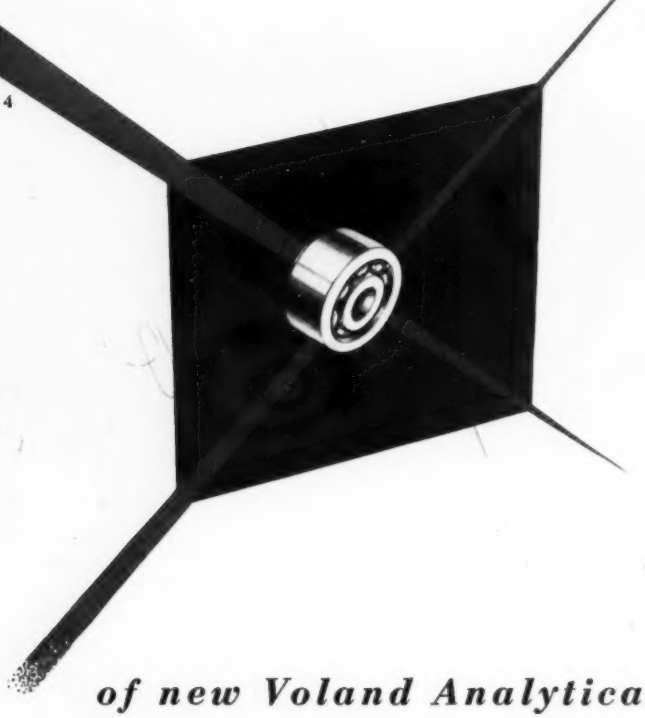

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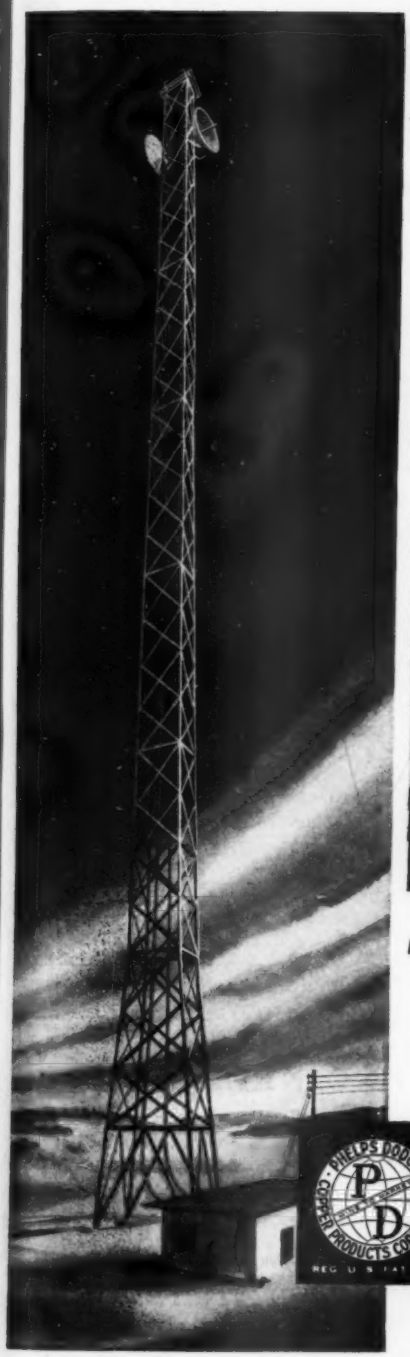

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THE TABULAR VIEW

Challenge.—Thrust into an unsought position of world leadership as the result of two World Wars into which it was forced, the United States is now the major power supporting a truly peaceful world composed of free men and free nations. As such, it faces a gigantic challenge in the military, political, and economic fields, from powers bent on world domination. The problems thus imposed on our nation are discussed in the "Challenge Facing the United States" (page 181) by WALT WHITMAN ROSTOW, Professor of History in the M.I.T. School of Humanities and Social Studies. Professor Rostow comes well prepared to deal with such topics, for his entire interesting professional life has been devoted to a study of history, economics, and international relations. Yale University conferred upon him the B.A. and Ph.D. degrees in 1936 and 1940, respectively. After a year of teaching at Columbia University and two years in the Army, from which he was honorably discharged with the rank of Major, Dr. Rostow went to England where, as Rhodes scholar and Harmsworth Professor of American History, he received an M.A. degree in 1946 from Oxford. In 1949 he received another M.A. degree from Cambridge University where he was professor of United States History. He served for two years on the Economic Commission for Europe, and since 1950 has been a member of the M.I.T. School of Humanities and Social Studies where, incidentally, Mrs. Elspeth D. Rostow is assistant professor of history.

Maturity.—The second and concluding part of an article, "Maturity through Student Counseling" (page 186), by DR. DANA L. FARNSWORTH describes the system of student counseling now in operation at the Institute. In the present system, which was developed while Dr. Farnsworth was head of the Institute's Medical Department, the difficulties which incoming students face in making the transition from preparatory school, or college life, are minimized through a counseling program that brings the new student into contact with Faculty members, as well as with upperclassmen, and makes full use of the principles outlined by Dr. Farnsworth in the January 1955, Technology Review. Dr. Farnsworth is a native of Troy, W. Va., and as recorded in his biographical data in this section of The Review last month (page 126), he was graduated from the Harvard Medical School in 1933. Technology's loss was Harvard's gain last summer, when Dr. Farnsworth became Henry K. Oliver Professor of Hygiene and Director of the University Health Services.

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(Concluded on page 174)

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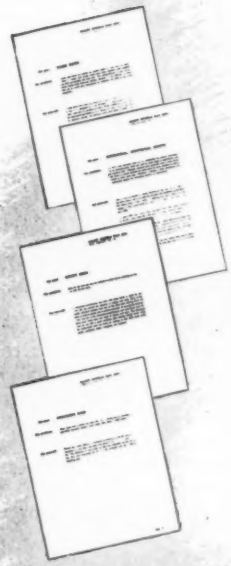

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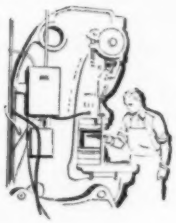

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THE TABULAR VIEW

(*Concluded from page 172*)

engineers—as a result of their professional training—is a valuable asset in public life. Engineers are called upon, in increasing numbers, to place their powers of logic, analysis, and objectivity at service in the public welfare through greater participation in political affairs. This exhortation is made in an article "Engineers in Politics" (page 189) by THOMAS C. DESMOND, '09, who was graduated *magna cum laude* from Harvard University in 1908 and from the Institute's Course in Civil Engineering the following year. For two decades, thereafter, he headed his own firm of consulting and contracting engineers, until his retirement from engineering work in 1929. Since 1930 he has been a Senator in the New York State Legislature, having recently been elected to serve his 25th consecutive year in that post. Senator Desmond was awarded the degree of doctor of humane letters from Union College in 1939. He has been active in alumni matters, a member of many Visiting Committees and, since 1941, has been a life member of the M.I.T. Corporation. Dr. Desmond's own engineering and legislative life lend convincing emphasis to the views expressed here.

Foresight.—There's more than meets the eye in the study (page 191) which FREDERIC W. NORDSIEK, '31, makes of human vision and the most common of optical aids—eyeglasses. Mr. Nordsiek, a skilled writer with more than 100 articles to his credit in the last decade, outlines the basic mechanism of human vision, discusses optical tests and methods of correcting the more common visual defects, discusses the assembly of eyeglasses—and sends the patient on his way with 20/20 vision. Mr. Nordsiek has been an editorial associate of The Review since 1944. Accordingly, he is well known to Review readers, not alone for the signed feature articles which appear in each volume, but also through the shorter, unsigned pieces in the Trend of Affairs section, which appear in almost every issue. Since his graduation from the Course in Biology and Public Health in 1931, Mr. Nordsiek has had a varied and interesting professional career devoted to various aspects of public health or the food industry. For the past several years he has been engaged in administering research grants for the American Cancer Society.

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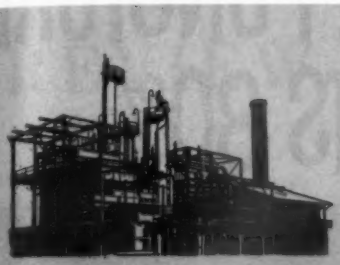
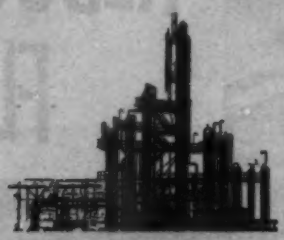
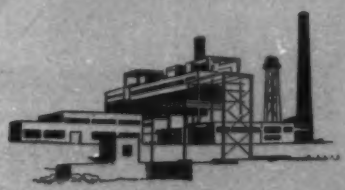


Petroleum Refineries



Chemical and Petrochemical Plants



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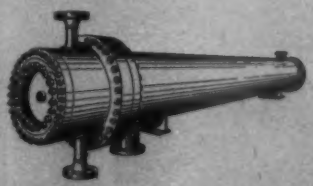

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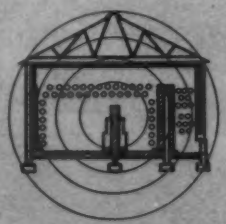

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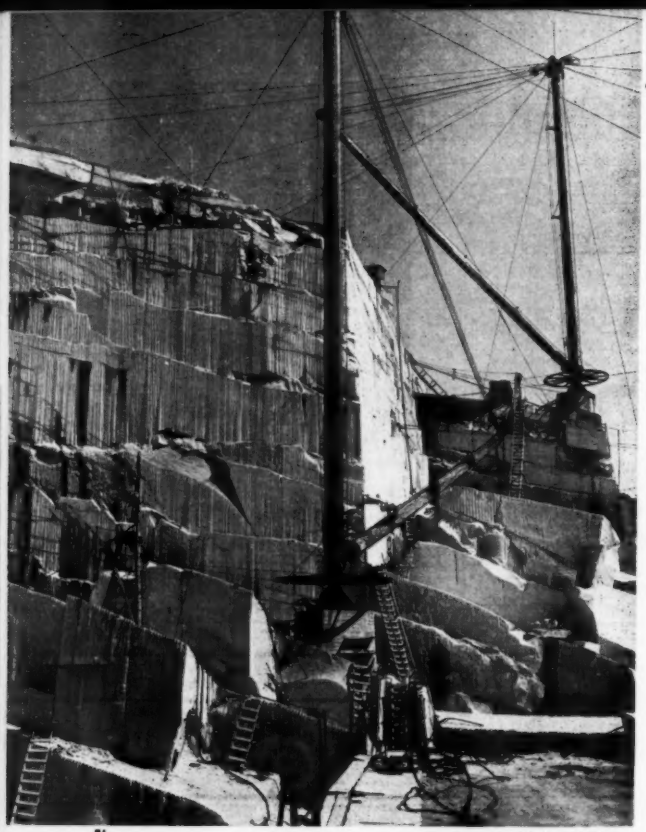


Ewing Galloway

The Builders

By Vannevar Bush

THE process by which the boundaries of knowledge are advanced, and the structure of organized science is built, is a complex process indeed. It corresponds fairly well with the exploitation of a difficult quarry for its building materials and the fitting of these into an edifice; but there are very significant differences. First, the material itself is exceedingly varied, hidden and overlaid with relatively worthless rubble, and the process of uncovering new facts and relationships has some of the attributes of prospecting and exploration rather than of mining or quarrying. Second, the whole effort is highly unorganized. There are no direct orders from architect or quarrymaster. Individuals and small bands proceed about their businesses unimpeded and uncontrolled, digging where they will, working over their material, and tucking it into place in the edifice.

Finally, the edifice itself has a remarkable property, for its form is predestined by the laws of logic and the nature of human reasoning. It is almost as though it had once existed, and its building blocks had then been scattered, hidden, and buried, each with its unique form retained so that it would fit only in its own peculiar position, and with the concomitant limitation that the blocks cannot be found or recognized until the building of the structure has progressed to the point where their position and form reveals itself to the discerning eye of the talented worker in the quarry. Parts of the edifice are being used while construction proceeds, by reason of the applications of science, but other parts are merely admired for their beauty and symmetry, and their possible utility is not in question.

In these circumstances it is not at all strange that the workers sometimes proceed in erratic ways. There are those who are quite content, given a few tools, to dig away unearthing odd blocks, piling them up in the view of fellow workers, and apparently not caring whether they fit anywhere or not. Unfortunately there are also those who watch carefully until some industrious group digs out a particularly ornamental block, whereupon they fit it in place with much gusto and bow to the crowd. Some groups do not dig at all, but spend all their time arguing as to the exact arrangement of a cornice or an abutment. Some spend all their days trying to pull down a block or two that a rival has put in place. Some, indeed, neither dig nor argue, but go along with the crowd, scratch here and there, and enjoy the scenery. Some sit by and give advice, and some just sit.

On the other hand there are those men of rare vision, who can grasp well in advance just the block that is needed for rapid advance on a section of the edifice to be possible, who can tell by some subtle sense where it will be found, and who have an uncanny skill in cleaning away dross and bringing it surely into the light. These are the master workmen. For each of them there can well be many of lesser stature who chip and delve, industriously, but with little grasp of what it is all about, and who nevertheless make the great steps possible.

There are those who can give the structure meaning, who can trace its evolution from early times, and describe the glories that are to be, in ways that inspire those who work and those who enjoy. They bring the inspiration that all is not mere building of monotonous walls, and that there is architecture even though the architect is not seen to guide and order.

There are those who labor to make the utility of the structure real, to cause it to give shelter to the multitude, that they may be better protected, and that they may derive health and well-being because of its presence.

And the edifice is not built by the quarrymen and the masons alone. There are those who bring them food during their labors, and cooling drink when the days are warm, who sing to them, and place flowers on the little walls that have grown with the years.

There are also the old men, whose days of vigorous building are done, whose eyes are too dim to see the details of the arch or the needed form of its keystone; but who have built a wall here and there, and lived long in the edifice, who have learned to love it and who have even grasped a suggestion of its ultimate meaning; and who sit in the shade and encourage the young men.

THE
TECHNOLOGY
REVIEW

Vol. 57, No. 4 February, 1955

The Trend of Affairs

Peppery Retort

THE condiments used at dining tables appear to follow cultural patterns. Thus, on oriental tables, is always found a bottle of soy sauce; in America, no table is complete without a salt shaker and a pepper shaker.

Salt, besides having a pronounced effect on the flavor of foods, serves an important nutritional function as a source of sodium ions. All mammals require an intake of sodium. Thus herbivorous animals, whose plant foods are low in sodium, must find access to salt licks in order to maintain well-being. Carnivorous and omnivorous animals, including the human being, ordinarily receive enough sodium in their foods, even without added salt. Indeed, human beings who suffer from certain illnesses, such as particular disorders of the cardiovascular system, may find it necessary to reduce their intake of sodium by eliminating added salt from the dietary.

Pepper has no nutritional value; it is used for purely gustatory reasons. Does pepper really promote the acceptability of foods, or are the casual sprinkling of pepper over the dinner plate and the usual addition of a dash of pepper during cooking purely traditional? This is a practical question to manufacturers of prepared processed foods, who need to know whether consumer acceptance of their products may be enhanced by judicious incorporation of pepper.

The question has now been clearly answered by a recent taste-panel study, using standard blindfold taste-testing methods, with results analyzed by statistical procedures of established validity. Thirty-two common foods were studied, falling into the categories of processed meats, soups, salads, vegetables, and miscellaneous foods. Foods prepared without pepper were compared with the same foods made with pepper, in concentrations determined by military or industrial specifications if available, otherwise set by the judgment of trained home economists.

For only seven of the 32 foods was there preference for those with pepper. These were Bologna, liver sausage, pork sausage, bean soup, chicken soup, vegetable soup, and fried haddock. With the remaining 25 foods, there was no significant preference between the peppered and unpeppered samples.

These results suggest that in many common American foods, at least, pepper is used only by blind custom and never would be missed were it omitted. Furthermore it appears that the hardship we all felt because of pepper shortages during World War II may have been quite irrational.

Nomographic Aid

SCIENCE and engineering are necessarily concerned with physical entities, quantitatively related. Consequently, mathematics in one form or another occupies a good deal of time of workers in technical fields. Those mathematical operations which lead to creative concepts must necessarily be done by exercise of human brain power, but the routine computations that lead merely to numerical results should occupy a minimum of time of trained personnel.

All engineers and scientists are familiar with the more usual forms of alignment charts in which numerical results may be obtained by reading the calibration of a line at the point where a straight edge, properly placed with respect to other calibrated scales, intersects the line. Sometimes, technical personnel have constructed nomograms to facilitate necessary computations. Too often, a stumbling block to the design and construction of more of these useful nomograms has been acquisition of the mathmatics needed for their construction.

A simple method of constructing nomograms from mathematical data or empirical charts, by a quick process requiring no knowledge of the mathematics of nomography, has been developed at the Institute by Douglas P. Adams, Associate Professor of Engineering Graphics. The method is quick, uniform, and as accurate as the original data and the care with which the draftsman works. Essentially, the method which Professor Adams has devised is a graphical means for transforming lines on a graph or network chart into corresponding points on an alignment diagram. There is ample mathematical justification for the graphical transformation which Professor Adams has devised, but the manner of use is free of mathematics. Another advantage is that the technique is applicable to problems in which quantitative relationships are known only empirically. The transformations required to convert a network chart into an alignment diagram, or vice versa, are made through use of a transparent plastic sliding sheet which can be readily prepared and is basically the same for any chart to be converted.

When an ordinary network plot consists of straight lines, the derived alignment diagram contains at least two straight parallel scales. When the network plot cannot be made to consist solely of straight lines, a "quasi-alignment" diagram results. The graphical method is also applicable to the most general type of network chart and then yields the most general type of alignment diagram.

Throatless Press

CONVENTIONAL forging presses utilize massive tension ties which connect the head and base, thereby providing the necessary reactions to the press forces. As the press capacity is increased, the head, base, and tension rods become very large and, for conventional presses illustrated in Fig. 1, practical problems of manufacturing and shipping the massive elements required create an upper limit to the capacities that can be realized. The largest known press of this type has a capacity of 50,000 tons.

For certain forging processes, the relatively narrow space between tension rods, called the throat, is disadvantageous. Yet the size of the throat, in conventional presses, is limited by the maximum practical dimensions of the press components.

To remove the present ceiling on press capacities and to overcome the operational disadvantages of the narrow throat of conventional presses, the structure of Fig. 2, originally conceived by C. A. van Dusen, has been developed. Here, the weight of a very massive concrete roof provides reaction to the press rams. When the press is not in operation, the entire mass of the roof is supported by two concrete walls which transfer this load to the foundation below. The clear distance between walls is very large, and the working space for forging operations is completely unrestricted.

The large size and unusual proportions of the throatless press introduce a number of unusual – if not unique – design features, and cause uncertainty regarding applicability of conventional methods of stress analysis and design. To study the distribution

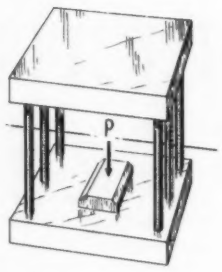
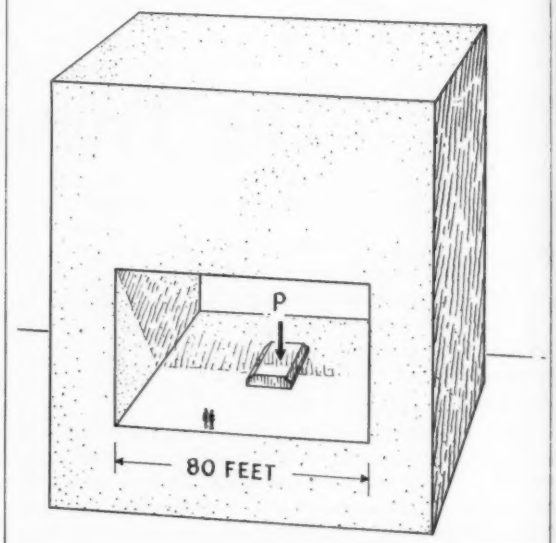


Fig. 1, at left, displays structure of usual press, with narrow throat limiting size of work.

Fig. 2, below, illustrates throatless press which can be made in sizes sufficiently large as to exceed capacity of conventional heavy presses.



of gross forces and unit stresses throughout the structure – and particularly within the roof mass – photoelastic analyses were carried out in the Institute's Department of Civil and Sanitary Engineering. The investigation was performed by Robert E. Jones, '53, research assistant, and Y. C. Loh, research engineer, under the direction of Myle J. Holley, Jr., '39, Associate Professor of Structural Engineering. The investigations were sponsored by the Austin Company, co-owners with the Hydraulic Press Manufacturing Company of the Throatless Press Company.

Two dimensional photoelastic analyses were performed to determine gravity load stresses and approximations to press load stresses. The stresses in three dimensions, under press load, were studied by measurement of surface strains on a Lucite model. The two-dimensional approximation of press loading was also studied by means of a lattice analogy solution for which computations were carried out on Whirlwind – M.I.T.'s high-speed digital computer.

The results of this investigation verify the structural feasibility of the throatless press and should prove of value in final design and construction of prototype structures whose capacity exceeds that of conventional heavy presses.

Challenge Facing the United States

We Have the Heritage of Ideas and Idealism, the Resources, and Talents Needed to Frustrate Communism

By WALT W. ROSTOW

This article was delivered as an address at the Naval War College at Newport, R.I., on August 25, 1954. Since that date a number of events have occurred—notably French acceptance of the Western European Union—that relate to this article. The text has not been altered, however, and, in the author's view, the line of argument developed here is still valid.—Ed.

THE challenge facing the United States is, in its essence, simple: can we prevent the enemy from fulfilling his intention? His intention is to drive the United States from power and influence in Eurasia; to isolate the United States on this continent; and to deal with us in his own good time from the preponderant base he would then control.

Is the enemy making progress toward his goal? He is clearly making important progress. What do we see as we look about the world? The enemy has apparently developed a capability to threaten the United States with grievous damage; and he has put himself in a position to blackmail our virtually defenseless allies with atomic attack and national destruction.

One of our major allies – France – has accepted terms of limited defeat from Communist China, thus exposing for infiltration or worse a major strategic area embracing India, Burma, and Indonesia. At just this moment the governments of those three vulnerable countries show signs of rejecting our world leadership and of seeking terms of accommodation with Communist China.

Japan, the Free World's major power base in Asia, is wracked by a chronic economic crisis, which rules out, for the time being, her assumption of appropriate responsibility – political and military – in Free Asia.

In the Middle East and in Africa conflicts long latent threaten to erupt, which the enemy has the intent and capability to exploit.

In Europe, European Defense Community, the mutual defense system we have long sought as an essential condition for European unity, seems on the verge of abandonment.

And finally, despite recent efforts, it is clear that the governments of Great Britain and the United States – inevitably the core of such Free World unity as there is – view this series of circumstances with different eyes and find the greatest difficulty in making common cause from day to day.

The unfavorable turn of events abroad in recent months has set in motion here at home an understandable but dangerous sense of frustration and hurt feelings – a tendency to blame our allies, who are indeed not blameless, and to look to more national solutions to our security problems. We are, as a nation, a bit disheartened with the policy of Free World coalition. This is reflected in American words and deeds abroad which push our allies further from us. And so, with a sharpened sense of vulnerability and fresh doubts of American purposes, they look weakly and somewhat pathetically to Moscow and Peking for amiable gestures which, costing nothing, are not denied them.

It is not too much to say that the designation of the United States as leader of a Free World may become an empty figure of speech if recent trends persist. We are threatened with an isolation brought about not by our own conscious decision but through an interacting process, involving in part the rejection of American leadership by our allies, in part the turning of the United States away from a coalition policy. Our feet are on the road – not far, but on the road – to becoming an awkward island off the mainland of Eurasia, thus fulfilling the basic intention of Moscow and Peking.

The enemy's challenge is not only real and immediate, it strikes at the heart of our national interest and our national security. Our national interest is to preserve and to develop in this republic a society based on the fundamental principles of individual freedom within the range permitted by government by consent. Our job is not merely to protect the handsome real estate which is our physical base; it is to preserve the still developing way of life which is the heart and meaning of America. Military means are, of course, absolutely essential to protecting our society; but if we are driven back to island status in a hostile totalitarian world, much if not all, of our national interest would be lost quickly – even without military defeat. Our kind of open society demands an environment of open societies about us, notably in a world of modern communications and modern weapons.

These are, then, the fundamental propositions: we are challenged by an intent to drive us from Eurasia; the enemy is making important progress in this direction; and this is a mortal challenge for the United States.

The general challenge we face has three specific dimensions: military, political, and economic. Each, in turn, will be dealt with briefly.

The military challenge comes to this: can we prevent the enemy from expanding his area of power in an age when he, as well as ourselves, has atomic weapon delivery capabilities sufficient to damage or to destroy whole societies?

It should have been clear from the beginning in 1945 that atomic weapons would constitute a transient and limited contribution to the security of the United States. It should have been clear that if we developed such weapons our potential enemies could and would also develop them. Atomic weapons carried with them a threat for the United States new in our history, new at least since the War of 1812; namely, that our enemies could inflict directly upon us grievous damage. It should have been clear that future major wars, if they came, would not be fought wholly on the territory of other peoples. In any case, it is now abundantly clear that the United States must live in a world of physical danger and insecurity, at least until effective disarmament is installed on a world basis.

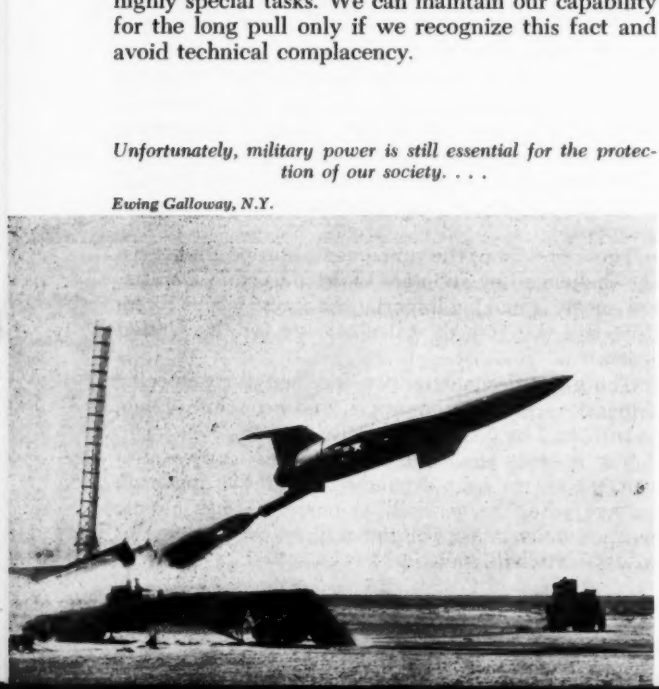
This does not mean, of course, that our atomic weapons are unimportant to security; nor that the degree of our danger is wholly outside our control. There is much to be done.

The maintenance of atomic weapon delivery capabilities, of the kind we now apparently have, can deny to any enemy, not bent on suicide, his ability to use them against us. The maintenance of this capability is not a static thing. The weapons, the means of their delivery, the means of defense are under constant development and change.

Until the very day – until the very day – when effective international controls are installed, we must maintain our ability to deliver overwhelming national disaster on our enemies and we must minimize his ability to damage us and our allies. This is an endless job in the world in which we live – a job not merely of allocating money and producing gadgets, but a job for creative scientists. And we must take great care that their contribution is woven positively into the tasks of national defense; for it is the essence of atomic weapons and their delivery that our capabilities are not a simple function of our steel capacity or of our industrial potential in general. They are and will remain a function of the best creative and original scientific achievement we can bring to bear on highly special tasks. We can maintain our capability for the long pull only if we recognize this fact and avoid technical complacency.

Unfortunately, military power is still essential for the protection of our society. . . .

Ewing Galloway, N.Y.



But a successful counter to our enemy's atomic weapon delivery capabilities is the beginning, not the end, of the military security task. Our enemy has noted that we have come to regard atomic weapons as our main strength. Just as the Russians worked around, blunted, and defeated Hitler's main strength – his ability to penetrate Russia with armored divisions – so they are seeking to work around our atomic weapon delivery capability by diplomacy, blackmail, subversion, and limited military operations which afford neither satisfactory atomic weapon targets nor a political setting in which we can find it possible to launch a direct attack upon the centers of Communist strength.

Here, then, is our major unsolved security problem: within the framework of our atomic weapon delivery and defense capabilities, how can we develop the forces to frustrate and ultimately to dissipate the threat presented by the Soviet and Chinese Communist power?

This problem has absolutely essential political and economic components: but it has a technical military side which deserves the most creative thought we can bring to it. Here, then, is the military position:

First, the enemy is extremely anxious to avoid the application to his structure of our weapon delivery capabilities. They carry to him a peculiar threat, not duplicated in the United States. These weapons threaten the continuity of his rule over his existing bases. With will and leadership our society would reerect itself after atomic attack. The continuity of Communist rule in Russia and China is threatened by such an attack. This is a potential source of strength to us in the test of will with which we live.

Second, while the United States wishes to avoid atomic attack, it must and should be prepared to face it rather than surrender. But our major allies in Europe and Asia, less protected than ourselves, will go to the greatest lengths to avoid such attack. It is a blunt truth, which we had better face quickly, that "massive retaliation" is incompatible with coalition strategy and perhaps incompatible with the maintenance of American power and influence in Eurasia, if – I repeat, if – it is the sole foundation of our military policy.

Third, we must, therefore, find ways of coping with the enemy's challenge by means short of our ultimate weapons, if our aim is to maintain our coalition and to stay in Eurasia. We must avoid situations where the enemy's limited aggression in Eurasia can only be met with our ultimate weapons, and the citizens and governments of the Free World in Eurasia are openly or covertly blackmailed into accepting limited defeat, rather than permitting us to use those weapons.

Fourth, in the last analysis, we must be prepared to confront the enemy with superior relative delivery capabilities, as a deterrent, and to fight and win a war with the ultimate weapons – if necessary on a bilateral basis – should his irrational action detonate a war.

Let me state this as plainly as I can. It would be a disaster to the American interest if we now took the view that we must simply prepare for the ultimate war; step by step this position leads to our isolation on this continent; that is, it leads to the achievement

of the enemy's objective. It would equally be a disaster if we did not maintain the capability to fight such a war to victory; for we could be bluffed to defeat or actually defeated. We must bend our energies to coping with the enemy's military threat by means short of ultimate war, holding our coalition together, holding the balance of power in Eurasia, while still maintaining a framework of superiority in delivery capabilities in the ultimate weapons.

What specifically do I mean by military means short of our ultimate weapons? First, in Europe, sufficient tactical strength – ground, naval, and air – to rule out a Soviet blitzkrieg to the Channel. I cannot pretend to full knowledge of the capabilities position in Western Europe; and I make the following observations with some reserve. But I do profoundly believe that Western Europe and the United States have the man power and resources to construct and maintain an effective screen against Soviet ground strength; for that strength in Central Europe has grave limitations as an offensive instrument. It is far from its production bases; its supplies must pass through territories which would demand in war enormous troop allocations to assure lines of supply; Eastern Germany is, from Moscow's perspective, a forward base subject to dangerous flanking operations from the Mediterranean. This is not startling news. Let it be simply emphasized that the popular conception of a Soviet ground horde poised in Central Europe, beyond our capabilities to match or to contain, is not accurate. The problem of protecting Western Europe on the ground is a problem of will and purpose and, to some extent, a problem of economic resources. It is not primarily a problem of overwhelming enemy capabilities.

Second, and probably more urgent, the Free World must develop in Asia notably, but elsewhere as well, new methods for coping with guerrilla and other limited operations, where the enemy's troops are apparently not engaged. Such operations usually reflect – as in Malaya and Indo-China – a weak Free World political base. But we live in a revolutionary world, where rapidly changing societies may well be weak and vulnerable to the enemy's methods of aggression. It should be one of our basic purposes to prevent situations from degenerating to the point where guerrilla and other limited operations can take effective hold. Nevertheless, we must be prepared to deal with them effectively, where they arise.

The challenge put to professional military men is the building of new techniques of limited warfare – including the limited use of atomic weapons – capable of containing the enemy's superior ground forces, just as our atomic weapon delivery capabilities contain his delivery capabilities; and of developing new techniques for dealing with limited forms of warfare, where these break out, as a result of the enemy's method of political subversion and guerrilla operations, in weak areas of the Free World.

This policy of military frustration throws fresh burdens onto our political and economic policy. These burdens are inevitable; that is, we cannot sit back comfortably and rely on "massive retaliation," for in the present state of the world that means the acceptance of defeat, the acceptance of United States isolation. Just as the civilian has a right to challenge the military with fresh thought on forms of limited warfare, the military has the right and duty to challenge the civilian to produce policies which will bind up the Free World effectively, maintain its political and economic health, and to avoid if at all possible the degenerate situations where military instruments must be evoked.

H. Armstrong Roberts

. . . but our real task is to preserve the still developing way of life which is the heart and meaning of America.

Nowhere is this view of the link between our political and security problems more clearly justified than in Asia. France and the Free World have suffered major defeat in Indo-China not merely because Soviet and Chinese arms crossed the Indo-China frontier. We have suffered defeat because France so conducted its political affairs in Indo-China that the peoples of that region would not rally to defend themselves against a Communist-dominated movement acting in the name of national independence. The Free World defeat in Indo-China was primarily a political defeat; and there will be no wisdom in our Asian policy unless we accept this fact. Nor can we blame this recent defeat wholly on the French. We backed with our money their Indo-China effort, knowing its weak political foundations, hoping for the best against our instinct and the facts. We had every reason to know from ample postwar experience that colonialism is an impossible base from which to fight Communism. We must not conceal our part in the common failure. If we acknowledge it maturely, we can go on to build a policy in Asia which will serve our own interests and those of the Free World.

I believe we can erect a united Free World policy in Asia because I am convinced that what the Asians want and what we want in that region largely over-

lap. By and large they want the time and framework of security to make good their freshly won independence in terms of economic development and domestic reform. Rightly or wrongly they interpret recent American policy as a negative obsession with the Communist menace; as a threat to the peace; and as a dangerous distraction from their own urgent tasks. To work with them we do not need to accept their sometimes myopic assessment of the Communist menace. We do need to align our energies and an increased margin of resources with the challenging tasks of economic and social transformation which engage them.

Beneath the surface of recent events there can be detected an increasing awareness in southeast Asia of the potential military menace of Chinese Communism. It was clearly reflected, for example, at the recent Ceylon Conference, and in Chou En-lai's reception at Rangoon. India and Burma have already exhibited a remarkable sensitivity to Communism within their countries, as well as an ability to deal with it. And given time, they will make a sound assessment of the international menace represented by Peking. But this they must come to themselves. In the meanwhile we have a very great stake indeed in the success of their economic and social policies. India, Burma, and certain other nations of the Far East are seeking to transform their societies into modern, growing nations by democratic political techniques – with the methods of consent – maintaining the concept of the integrity and inviolability of the individual human being.

Up in the North the Chinese Communists have launched an economic plan which seeks to reproduce on the Asian scene the transformation painfully wrought in the Soviet Union in Stalin's First Five-Year Plan. It is being conducted in China with a human ruthlessness which matches its model.

The political and military future of Asia is likely to be determined at least as much by the relative outcome of the Indian and Chinese economic efforts as it is by the strictly military events of the next decade. This does not mean that we should abandon the attempt to bring into being a collective military alliance in Asia, or that we should abandon our bilateral efforts to strengthen the effective military strength of Free Asia. On the contrary we need such an alliance and such bilateral undertakings, and the commitment of cope with a commonly understood danger which underlies them. It does mean that we should not confuse such military arrangements with a total Asian policy; and that we should be prepared to enlarge our co-operation with the developing areas of Asia, whether or not they are prepared now to join in a required military alliance, or in bilateral military arrangements with us.

Into such a sustained constructive effort the United States should be prepared to throw increased resources, increased technical and scientific skill, and perhaps most important, increased human understanding and moral support.

I might add that only substantial economic growth in Free Asia as a whole will create an environment within which Japan can solve its most serious balance of payments difficulties and attain the self-supporting status its great energies and talents deserve, and the development of its political and military potential demands.

The problems we confront in Asia differ only in degree and urgency from those we confront in the rest of the world. In the Middle East, in Africa, and on our own doorstep in Latin America the horizon of ambition of men and women has lifted. They want and expect for themselves and their children not merely increased material welfare, but increased personal and national dignity. There is no doubt at all that historians of the second half of the Twentieth Century will mark as its central feature this massive human awakening to the best, and sometimes the worst, values of Western civilization.

Anyone who has had even a slight connection with our postwar affairs knows that this revolution in human expectation raises difficult day-to-day problems for American policy making. Revolutions refuse to behave like well-run corporations. There has been and there will be plenty of difficulty in the process of transformation now proceeding all around us.

But we Americans should welcome this transformation and align our national policy with it. For the combination of human dignity, national independence, and material advance which men and women now seek with increased vigor are precisely the things for which the United States has long stood and for which our society at its best still stands.

To align ourselves with the revolutionary transformations now proceeding will take more than an economic policy, more than money and technical assistance. We must take an active part in engineering the transformation towards independence in those areas where colonialism still exists. There are no easy and automatic formulas here. Independence cannot come everywhere tomorrow; and the job of making healthy free societies does not end with a formal achievement of independence. But the active weight of the American influence must be steadily directed towards hastening the process of responsible independence by peaceful transitional measures.

We must be energetic before grave crises are upon us in these revolutionary areas of the world. That is the true lesson of Indo-China. There are ample warnings in Africa and elsewhere which we should now be heeding.

What has already been said implies that the United States requires a new economic foreign policy to match the military and political policies needed to maintain a Free World coalition and to hold a balance of power in Eurasia. When we think of economic foreign policy we tend to think of the ancient subject of tariffs, on the one hand, and the modern subject of United States gifts abroad, on the other. Lower American tariffs and the use abroad of America's economic resources have a place in any foreign economic policy for this period of our history worthy of the name. But there is more shape to the economic problem of the Free World than is generally realized; more fresh thought required; and more unexploited possibilities.

Basically, we face in the Free World two economic problems; and the central task of United States economic foreign policy is to so marry these two problems as to make them mutually supporting assets.

One problem is that of the industrialized areas in the Free World, the problem of Britain, Germany, and Japan. They require expanding markets for their manufactured exports and expanding sources of foodstuffs and raw materials coming from places in which they can sell their own goods.

The second problem is that of the underdeveloped areas of the world which seek to develop and modernize their economics so that they can attain self-sustaining growth.

The answer, broadly speaking, is obvious enough. The underdeveloped areas must grow fast enough so that the Free World offers adequate markets for the industrialized countries; the underdeveloped countries must include within their development programs not merely new industries, but enlarged output of goods which are needed in Germany, Britain, and Japan; and the industrialized countries must provide the sustained flow of technical assistance and capital equipment to bring about this balanced growth.

In making such a partnership for balanced growth in the Free World, the United States has a decisive role to play. It must generate and export increasing amounts of capital, both to accelerate economic growth in general and to increase the output in the Free World of the foodstuffs and raw materials the Free World's industrial areas require. It must continue unrelentingly the battle to lower tariffs and make the American market a more vital element in the Free World economy.

Specifically we must now launch and sustain a major new investment program in the Free World – truly an investment, and not a give-away program. A large part of the growth problem does not depend on capital at all. It depends on the will of men to undertake new productive tasks; on their energy; on their technical ability; and on their managerial ability. We can contribute something substantial in these directions through technical assistance; but the job must take place basically in the developing areas. Beyond this, a sustained flow of United States investment capital could help mightily, both in itself and as a stimulus to further efforts within the developing economies.

In order to justify a program of this kind we must bear in mind that economic foreign policy is not an instrument designed merely, or even primarily, to advance the American economic interest; although a foreign investment program of this kind is much to the nation's economic advantage. Its primary purpose is to help the nations of the Free World achieve that material progress which is essential for the highest purposes we share: human dignity, national self-respect, and the maintenance of societies worth defending.

Given the nature of the enemy's methods of infiltration and subversion, and the relation between economic progress and political viability in many areas, there is a direct and vital link between our military problem in its narrow sense and a program for economic growth in the Free World.

But what of the situation in the camps of our enemies? Is there any assurance that if the United States should now strike out along those lines that Communist military efforts could be frustrated and

Ewing Galloway, N.Y.

The primary purpose of our economic foreign policy is to help the nations of the free world achieve that material progress which is essential for human dignity, national self-respect, and maintenance of societies worth defending.

Communism itself defected in a political and economic contest? I believe there are ample grounds for such assurance.

In the Soviet Union, Stalin's successors are caught up in his heritage of overconcentrated power, a distorted economy, and a smoldering empire. There is powerful resistance among the generation of bureaucrats raised up by Stalin to accepting another all-powerful dictator. But they confront the dilemma of limiting the powers of the secret police over themselves without loosening the hold of the Kremlin over the restless Russian peoples.

Grave problems beset Soviet agriculture whose solution in fact requires that the stultifying framework of political and social controls over the Russian peasant be altered. Although Stalin's successors have publicly exposed the problem of agriculture, they have not been prepared to take the profound steps required for its solution.

These men have on their hands the massive, wasteful system of forced labor, a monument to the momentum and vested interests of a police state at its worst. They know its costs; but to dismantle it would disrupt the system of rule they still operate, and challenge its basic power precepts and methods.

They confront Stalin's heritage in the satellites as well. Moscow took each logical step toward total power in eastern Europe; but now it faces the costs and dangers of its position as a universally hated occupying power, a technique of imperial rule notably insubstantial for the long pull.

(Continued on page 208)

Maturity through Student Counseling—II

The System of Counseling Now in Vogue at M.I.T. Brings the Incoming Student into Contact with Faculty Members as Well as Upper Classmen

By DANA L. FARNSWORTH

Part I of Dr. Farnsworth's article, which appeared in the January, 1955, issue of The Review, discussed the forces affecting the development of maturity in college students.

THE assumption that teaching and counseling are essentially one process brings up a number of fundamental questions that are sometimes rather disturbing. For instance, an occasional teacher may be somewhat concerned because he feels that he has bargained to teach mathematics or physics and has not included in his thinking the idea that he is probably going to have to teach students as well. The idea that the counselor is a specialist in indirect education violates some of the traditional concepts of teaching which are held by many people. Some may feel that attention to the individual means that less emphasis is going to be placed upon subject matter. The concept that attention to the individual is designed to help free him from distractions in order that he may work more effectively is not accepted by everyone. It is a shock to some faculty members to realize so bluntly that what they do, say, read, wear, enjoy, and every aspect of their manner and behavior affect their students so directly and strongly. It is not exaggeration to say that, for the first year or two a counseling system is in effect, the counselor himself probably gets more out of his new activities than the person who is assigned to him.

Before proceeding further with a discussion of some of the theoretical and practical aspects of counseling, the writer will sketch briefly the system with which he is most familiar and which at least seems to be working with some degree of satisfaction.

The system of student counseling now in vogue at M.I.T. is made up of two parallel but co-operative parts. The first of these involves the Faculty, and the second, senior or junior undergraduate students. The original plan was devised by a Faculty committee, working in co-operation with the office of the Dean of Students and other administrative officials. At present it applies particularly to the first year class. Faculty counselors, 62 in number, are chosen from a list submitted by the head of each department and made up of those persons who are willing, and, in some cases very desirous, of doing this work. Each individual Faculty member is assigned no more than 15 students. The great majority of the counselors are of professorial rank of one or the other of the three grades. During freshman orientation week the counselor sees his students in a group, usually in his office; he may see them once in a social situation and for the most part sees each one of his students separately. He also serves as registration officer for the freshman. After school officially opens, he is then available at a set time each week for his advisees to consult with him upon any issues that may come to their attention. The mid-term grades which were formerly sent directly to the student or to his parents are issued through the Faculty counselor, thus creating a reason for a contact under very normal circumstances.

Since the whole body of Faculty counselors known as the Freshman Advisory Council is too large to have frequent meetings, an executive committee is elected from this group, consisting of about 12 members, each one of whom represents four or five other Faculty counselors. The Council is presided over by a professor who is chairman of the Council and is aided in his work by an executive officer, who is an assistant professor. In addition, there is an executive secretary for the whole counseling system, who maintains an office which serves as a central clearing house for the exchange of information, for referring a student to someone in a special field and for solving the many complicated and perplexing questions that arise from time to time. The Executive Council meets at periodic intervals, usually about every two or three weeks, to discuss any questions which may come up regarding the students themselves or regarding the mechanism of the counseling program. In addition, a series of meetings are held, usually from seven to 10, during the year, which may be attended by any member of the Freshman Advisory Council or by the registration officers of the three upper classes. At these meetings typical situations that arise from time to time in counseling interviews are discussed. These discussions may be led by one of the Faculty members, by a member of the psychiatric service, by Faculty members from other schools who are interested in student counseling problems, or by anyone who may have any special point of view to present.

The student part of the counseling system is not as well organized as yet as the Faculty portion. A corps of student advisers is chosen by representatives of student government from volunteers. A meeting of all the advisers is held early in the term, at which various speakers from the student body and from the Faculty explain some of the philosophy of student

counseling, common problems that are likely to be encountered, the resources available in the Institute for those students who have difficulties, and questions are answered. There is a student advisory council somewhat similar to that of the Faculty Freshman Advisory Council, which meets from time to time to discuss the mutual problems that may come up. The students, too, have occasional meetings at which time special points of view are presented. For instance, not long ago a panel was held for first-year section leaders on the question of freshman-sophomore rivalry, hazing, and associated matters.

In practice it works out that each first-year man has a Faculty adviser and a junior or senior adviser. The student thus has to use considerable ingenuity if he does not make the acquaintance of two people the very first week of the term who are desirous of being friendly with him and who can help him in the adjustments that he is called upon to make.

One of the basic assumptions behind the philosophy of student counseling which the writer has been describing is that we in the college might be of greater aid in the development of our students if we steadfastly maintain the attitude of being colleagues to our students in all matters—colleagues with greater experience in living, but all students together. All too often we are told that college authorities take the place of the parents, thus making one big family, so to speak. Acting on this assumption, we will perpetuate for the student many of the very same influences which bother him, cause him to feel that his dependence is being continued, and incite him to rebellion. The futility of thinking that college authorities can take the place of the parent is shown by the fact that most parents cannot themselves continue the traditional parental roles of authority without exciting a great deal of resistance in the form of hostility, rejection, or "acting out" of feelings in unacceptable behavior.

What we in the colleges need is a new idea of what our role toward students should be. Instead of trying to keep them out of trouble by protecting them, we need more emphasis on developing built-in controls. Rather than relying on the guiding influence of home, we should build upon those influences which are helpful and try to create an environment in college in which self-control is looked upon with the highest approval. The writer would even go so far as to recommend that some way be devised to include qualities of character, integrity, judgment, and self-discipline in the grading system and that the grading system itself have in it less emphasis on the purely intellectual accomplishment. Not that there should be any lowering of standards—far from it. Rather, the idea needs encouragement that knowledge is not enough; what is just as important is the meaning behind the knowledge.

The attitude and philosophy of the counselor himself is very important, in fact crucial, if such a program as described is to succeed in improving the educational process at college. Some teachers are not suited to be counselors, either because they do not enjoy such contacts with students, or because their own anxiety may be too greatly stimulated by contacts outside class. A few are not satisfactory because they are too enthusiastic, usually in the direction of some special technique or approach, to the neglect of a more rounded view of college life. The great majority of college faculty members, however, are not only well qualified to perform counseling functions, but find that such experience enriches classroom contacts and is a source of enjoyment.

The good counselor is in effect a specialist in indirect education. He has contact with the student as he is in the process of making important decisions, and is therefore in a position to reflect with him upon the meaning of knowledge and the subtle but significant considerations that are weighed when choices must be made with "insufficient and constantly changing facts." As Whitehead has said, in him the student sees "an ignorant man making use of his small store of information." He looks at the academic scene through the student's eyes and tries to understand it from his point of view without getting too identified with the student. He is a catalyst in self-understanding, both of the student and himself. He is a center of communication and knows who possesses or has access to special skills or knowledge that may be needed. He cultivates the judicial mind, thinks of other possibilities, shares perplexities and grows with his younger colleagues, listens well and conveys enthusiasm for learning and integrity.

He helps his student formulate his problem, rather than solving it for him, seldom gives direct advice and does not feel obligated to help every student, since there are no solutions to many problems. In such instances his sensitive and intuitive understanding may be of the greatest aid to the student in tolerating a difficult situation. He does not pass moral judgments but helps the student to do so for himself. Most important of all, he does not probe into the student's private affairs but lets him divulge what he chooses in his own way and at his own rate. And he must always keep in mind that what the student comes to consult him about may not be what is really

worrying him, but that the student is trying him out, seeing what kind of a man he is, and trying to judge whether or not he will be able to handle confidential material comfortably.

In the field of problem solving there are a good many situations which come up that can be worked out for the most part by the Faculty member himself, possibly with the aid of some of his associates. These include cutting class, less serious instances of plagiarism, choice of course or career, courtship problems, lack of interest, feelings of insecurity, homesickness, and a host of other minor interferences with the accomplishment of good work. Then there is another class of difficulties in which the counselor may be able to be of help by playing a supporting role or he may need to consult with a professional, whether he be a chaplain, a clinical psychologist, social worker, or psychiatrist. These include anxiety states, bodily symptoms, mild mood swings, sleeplessness, panic in examinations, and instances in which the student has overreached himself by going out for more activities than he can accomplish successfully. Finally there are some very serious symptoms that practically always call for specialized help of one kind or another. These include bizarre behavior that "just doesn't make sense," overactivity with excitement and increased irritability, exhibitionism, suicidal threats or acts, homicidal threats, overt homosexual behavior, and the peculiar habits of that large group of emotionally unstable persons who are sometimes spoken of as psychopaths. Fortunately for the college counselor this type of individual usually gets weeded out earlier in his educational career, but a few of them do get into college.

The general goals of the counselor-teacher in education have much in common with those of psychiatry. In my opinion psychiatry confirms the dignity of the human being in any and all circumstances. It stands for his freedom to develop to the fullest extent of his ability. It works for the development of the individual so that he may have deep integrity, a feeling of responsibility, and will be in a position to exercise the best possible value judgments. It believes in tolerance, not of the condescending variety, but of the more innate kind which does not even assume an inferiority which one is then willing to overlook or forgive. Its work is entirely consistent with that of religious groups and the aspirations of all men of good will. It believes that an understanding of unconscious forces is necessary in many situations as a supplement to knowledge of conscious forces. It tries to take common sense into consideration but goes beyond common sense in that it attempts to see behind the motives which induce man to put his best foot forward and to see behind the self-deception that all persons practice without being entirely aware of it. Any adjustments that are encouraged by psychiatry are designed to free the individual from distracting conflicts rather than to cause him to function comfortably at a lower level. Psychiatry looks to the long-term welfare of the man or woman and is firm in its insistence on the patient's developing his own standards, as high as his background and experience will permit. The counselor thus, in co-operation with his colleagues, constructs a fundamentally sound college community structure in which mature thinking can frequently be observed and experienced, while his professional colleagues, the psychologists and psychiatrists, aid him in complicated situations outside his own area of competence, with constant teamwork being both desirable and necessary.

Because of the writer's clinical background the problem solving aspect of counseling is apparently over-emphasized in this article. It cannot be too strongly emphasized that this aspect of counseling is a secondary, albeit an important, one. The real purpose of a counseling program is to raise the standards of teaching and learning throughout the whole institution, and most particularly with the brilliant students. Furthermore, the writer is in complete agreement with the idea expressed in the Harvard report on advising, issued in November, 1950, that counseling should be associated with the intellectual activities for which the college exists.

It should be emphasized that the relationship between a counselor and student continues unchanged while the student is receiving help from someone with professional skills. The counselor is not an amateur therapist of any variety, hence does not need to feel threatened by anyone. He is the person in the student's life who plays the role of friend to the student during that awkward period when he has not had time to form his own "natural" connections.

The development of a counseling program, such as has been described, poses some very difficult problems especially in the larger schools. Our society is making increasing demands on everyone who assumes social responsibility as part of the duty of being a good citizen, and this is particularly true of the teacher. To be a good counselor takes time, and how is extra time to be found? To do no counseling also takes time for someone in many instances, and not time well spent. A basic concept in this philosophy is that any contact with a student is a counseling situation. Hence, by giving thought to the whole process of personal interaction that occurs, the quality of the relationship may be improved. Indeed, it is not too much to hope that after nearly all faculty members have served in a formal counseling program of this type, a formal system will become less necessary. Care must constantly be taken by those involved in educational planning not to get the individual teacher loaded with so many extra duties that he loses the feeling of freedom and independence so desirable for effective scholastic activity.

It is not too much to hope that careful attention to the needs of the individual by a counselor will, in the long run, change the general attitude on any campus from a somewhat rigid, intolerant, unthinking one to a most considerate, friendly, permissive one, which at the same time exerts steady unrelenting pressure on every student to develop high personal and collective standards of honesty, integrity, and accomplishment. Of many students – and an increasingly large number each year – we may hope it can be said, as it was of Sir Robert Shirley in 1683 that his "singular praise it is to have done the best things in the worst times and hoped them in the most calamitous."[3]

3. Sperry, Willard L., *Sermons Preached at Harvard*, page 187 (New York: Harper and Brothers).

Ewing Galloway

Engineers in Politics

Government Will Approach More Closely the Ideals of This Republic's Founders When More Engineers Take a Greater Part in Politics

By THOMAS C. DESMOND

IT was my good fortune to study civil engineering at the Institute during the period when a great teacher and engineer, the late Professor George F. Swain, '77, was head of the Department of Civil Engineering. After being graduated from the Institute in 1909, I engaged actively in engineering and construction work in various parts of the United States for the next two decades. With considerable good luck in this feast or famine business, I was able to retire entirely from engineering work and related business activities, and in 1930 returned to live again in my native Orange County, New York.

In November, 1930, I was elected as a Republican member of the New York State Senate, and through successive re-elections I am now in my 25th consecutive year as a member of this Senate. A quarter-century experience as an engineer in politics has led me to three conclusions: (1) Both externally and internally, the United States of America faces more serious dangers than ever before in its history, although these are still unrealized by many persons; (2) It is high time that engineers, who have contributed so much to our material advancement, should co-operate with other men of good will toward our political advancement; (3) The United States must not be permitted to fail in its noble mission of demonstrating, to a dictator-ridden, troubled world, the success of democratic institutions.

Long political experience as a member of the New York State Senate, as a delegate to two Republican National Conventions, and as a member of various Republican political clubs and committees, has afforded me opportunity to associate with many lawyers, but with few engineers. When applied to social and political problems, engineering principles of logical analysis can be most helpful. Of course, logic should be accompanied by sympathy when we deal with problems of human beings, and sometimes this need is difficult for engineers to master. Still, if more engineers had been in positions of political adminis-

tration, I believe they could have contributed highly constructive points of view toward many decisions.

At the 1954 session of the New York State Senate, for instance, the 56 members included 33 lawyers. Such a high percentage of lawyer members naturally led to lawyer-dominated decisions. On many matters of considerable importance, the judgment of those trained as engineers would have been helpful.

When he draws a deed or other legal instrument, a good lawyer quite properly looks backward to follow old – and sometimes almost archaic – forms. On the contrary, a good engineer must constantly be alert for new methods to solve unique problems. Intellectual habits, thus formed, often persist. An improvement in our political institutions might well result if a greater number of forward-looking engineers and fewer backward-looking lawyers were influential in politics.

I believe most earnestly in the essential goodness of human nature, in the ideals of our republican form of government, and in the high probability of ultimate response, by the uninformed, to leadership which is trusted to be enlightened, capable, and honest. But in politics there is, at present, a great lack of such leaders who are active on local, state, national, and international levels.

Engineers are certainly not the only kind of informed and altruistic men who can or should provide leadership in civil government. But to engineers in particular, in this modern age of technology, such acceptance of leadership now is a special obligation. And it will be a noble and enduring satisfaction to any engineer – as to any other man or woman – to realize that he is doing his share to maintain, with reasonable efficiency, our free institutions.

An analytical thinker, reading my laments that so few engineers and other objectively minded and able people are now influential in policy-forming political positions, might wonder how the country has been getting on so far and so well without them. Someone might say to me: "Yes, the ideal might be to have more engineers in politics; but, after all, engineers are mostly busy men, doing other useful work. Moreover, even granting that it is run by professional politicians, the country is nevertheless now the greatest and happiest country in the world and is doing rather well just as it is."

Ewing Galloway

To these plausible comments my earnest reply is (and how I wish I had the ability to emphasize what I have in mind more persuasively): "So far our country may have progressed well despite present poor politics. But this does not prove that our country will, nevertheless, continue to be both great and safe, if poor politics, leading up to poor statesmanship, continues in the future."

In previous generations the United States had to fear but relatively little, the results of bad politics and bad statesmanship. But those evil twins may lead us to catastrophe in this hydrogen bomb age. Always it would have been better if more of our ablest men had been engaged in government, rather than merely in business; now the need for their participation for the public welfare is imperative.

Let us contrast conditions as they are now with what they were, say, only 50 years ago. During this short span of time, engineers have contributed much to the development of automobiles, aviation, radio, labor-saving devices, and other technological improvements, all of which have made our country technologically so superior to what it was a half century ago.

But no one can honestly say that the quality of our government has made comparable improvement in the last 50 years. Our government has become increasingly complex; it has become much more important than it was 50 years ago, for now it affects even the daily lives and happiness of all of us.

My hope is that, in the years to come, many more capable minds will be devoted, in part at least, to the urgently needed improvements in our political and governmental institutions. The problem calls for the application of capable, well-trained minds, such as are possessed by graduates of M.I.T. and other engineering colleges. It calls for minds of the kind that have produced the great technological transformation of the past half century. Of course machines are important, but men are of very much greater consequence. Technological improvements are important, but progress in the art of human relations is even more significant. A world that knows television should not still know bayonets.

To all young engineers just starting on their engineering careers, I heartily commend part-time political activity; a duty of every citizen, but seldom now performed. To these young engineers, I would also state that political experience may also provide for them unusual educational advantages in developing their qualifications for business leadership.

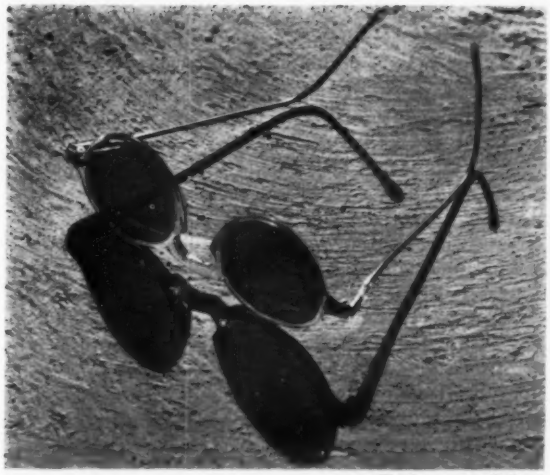
In technical schools, engineers learn to deal with factual data, that for the most part, are fixed. But political problems largerly concern shifting data, and the obstacles are often human – not inanimate and predictable. The same distinctions of dealing with shifting, rather than fixed, data apply to the work of the president of a company as compared with that of a chief engineer.

Early political party experiences may be especially helpful to an ambitious young engineer who aspires to qualify, eventually, for a well-paid and important executive position. And in his later successful years, when he is expert in evaluating shifting, as well as

(*Continued on page 202*)

Through a Glass, Darkly

By FREDERIC W. NORDSIEK



H. Armstrong Roberts

For Better Vision in the Many Years Ahead

Apparel, Stylish, Can Be Bought for Ev'ry Head

It isn't that more people are wearing eyeglasses nowadays; it's just that glasses have become more obtrusive. Thus a few decades ago the well-dressed executive wore pince-nez spectacles, having small rimless lenses supported by a bit of metal across the nose. But today's modish business or professional man looks through large lenses, set in heavy dark plastic frames. The distaff analogue of the masculine horn-rimmed spectacles are those eyeglasses of bizarre shapes and vivid colors, often bedizened with rhinestones or glittering metal embellishments, worn by the stylish woman of today. Indeed some women include in their wardrobe an assortment of eyeglasses, and daily select a pair to harmonize with their costume, as meticulously as they choose their jewelry for the day.

Thus eyeglasses, once considered a deterrent to human vanity, have now become an element of good grooming. Dorothy Parker's classic dictum "Men seldom make passes at girls who wear glasses" no longer holds true. Spectacles are indeed today regarded as contributory to feminine allure; high-fashion models are often provided with eyeglasses as part of their costume for advertising photographs.

The current glamour value of eyeglasses is also apparent in the theatrical field. Not long ago, actors would not appear before their audiences wearing eyeglasses, except in character roles. Theatrical folk who simply could not get along without optical aids resorted to contact lenses. But today numerous entertainers habitually affect eyeglasses of the most obvious sorts. Indeed this trend has given rise to a new form of theatrical art, frequently seen on television and in night clubs; this type of entertainment is called "literate humor" and is defined as "the old, sure-fire jokes told by a young man wearing eyeglasses."

How fortunate it is that human vanity no longer militates against eyeglasses; for few people get through life without them. Many persons are fortunate enough to be free from nearsightedness, farsightedness, astigmia, and such visual difficulties in early life; but few pass middle age without developing *presbyopia*. This is the difficulty in visual accommodation, resulting from aging of the ocular apparatus, that characteristically manifests itself, around the age of 40, by development of difficulty in focusing on nearby objects.

Since the wearing of eyeglasses is well nigh universal, it is of interest to know what human visual frailties may be relieved by spectacles, and how these ocular difficulties are assessed for the purpose of fitting eyeglasses.

Human Vision

As the author has pointed out previously in the pages of this periodical, vision is undeniably the cardinal human sense.* Also set forth in the article cited is the concept that vision, like the other human senses, is a total subjective reaction to stimuli that may be objectively measured; in other words a psychological response to physical stimulation. Thus the physical characteristics of light – its wavelength and intensity – may be precisely measured by laboratory instruments. The image conveyed by light reflected from an object may be accurately registered on a photographic emulsion, by means of a camera. But when light conveys an image into the human eye, the sensation experienced by the recipient depends not only upon the physical characteristics of the entrant light, but also upon the curvature of the cornea or outer layer of the eyeball, the clarity of the crystalline lens of the eye, the state of health of the vitreous humor, retina, and other eye structures, the action of muscles in focusing the crystalline lens and in converging the two eyeballs if the object viewed is nearby, the action of nerves in transmitting to the

* Frederic W. Nordsiek, "All Experience Is of Change," The Technology Review, 53:22 (November, 1950).

brain the impulse generated at the retina, and finally the action of the brain in interpreting this impulse. Manifestly most of the phases of this sequence lie beyond the effectiveness of eyeglasses. Eyeglasses can indeed influence only the initial steps in this complex series of events that add up to constitute human vision. Spectacles, in the main, can do no more than offset optical shortcomings of the cornea and crystalline lens, and compensate for weaknesses of the muscles that focus the crystalline lens, or of other muscles that control the relative movements of the two eyeballs.

Defects of Vision

As all who have been exposed to high school science know, the human eye – considered purely as an optical instrument – may depart from optical perfection by being nearsighted (myopic), or by being farsighted (hyperopic). Parallel light rays entering the optically perfect eye, while the focusing mechanisms are entirely relaxed, come to focus upon the retina. (See Figure 1 for a diagram of anatomy of the eye.) In the nearsighted eye, light under such conditions focuses in front of the retina, with the result that a clear image is not seen. This difficulty is remedied by placing before the eye a diverging (concave) lens of suitable focal length. In the farsighted eye with focusing mechanisms completely relaxed, parallel rays do not come to focus anywhere within the eye structure; if projected, such rays would focus behind the retina. Eyeglasses to remedy farsightedness are converging (convex) lenses.

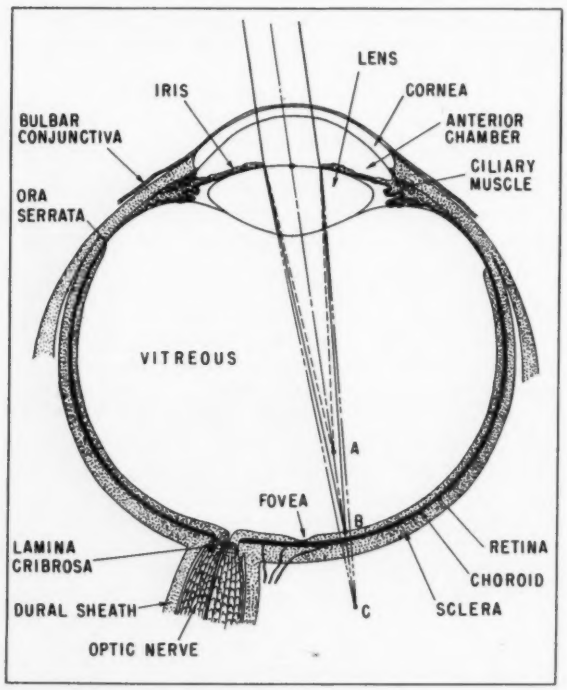


Fig. 1. Horizontal section of the anatomy of the human eye. In the optically perfect eye, entering parallel rays come to focus on the retina (B), whereas for nearsighted persons the point of focus is in front of the retina (A), and for farsighted persons, it is beyond the retina (C).

A third common optical defect of the human eye is astigmia. This condition is an irregularity in the light-refracting system of the eye, in the form of a departure from spherical curvatures; in other words, unequal curvatives in different meridians. Astigmia may readily be conceived by squeezing a tennis ball between the fingers and thumb until it is no longer spherical. A ball so compressed provides a good idea of the contours of an astigmatic cornea; for the seat of most astigmia in the human eye is the cornea or transparent forward outer layer of the eyeball.

Astigmia is rectified by the use of cylindrical lenses. These lenses are made with the same deviation from spherical curvature as the eye, and in use are positioned so that the axis of the lens distortion is perpendicular to the axis of the eye distortion.

Thus nearsightedness, farsightedness, and astigmia may all be considered as optical defects of the refracting media of the eye, comprising the cornea and the crystalline lens behind the cornea. Two more human visual frailties will be discussed, that stem not from optical defects, but rather from shortcomings in muscles, or in resiliency of eye structures.

One of these troubles is presbyopia, already mentioned. Presbyopia results when, in middle age, the crystalline lens of the eye loses some resiliency, and the ciliary muscles that change the contours of the crystalline lens for focusing purposes lose some of their strength. The focusing mechanism provided by the crystalline lens and the ciliary muscle comes into play only when nearby objects are viewed; for as indicated previously, the normal human eye relaxed (that is, with the focusing mechanism not in use) focuses parallel rays, as from distant objects. Hence presbyopia initially manifests itself as progressively increasing difficulty in seeing nearby objects clearly, although the distance vision remains unchanged. It is rectified with convex lenses. Some ramifications of presbyopia will be explored a little later in this article.

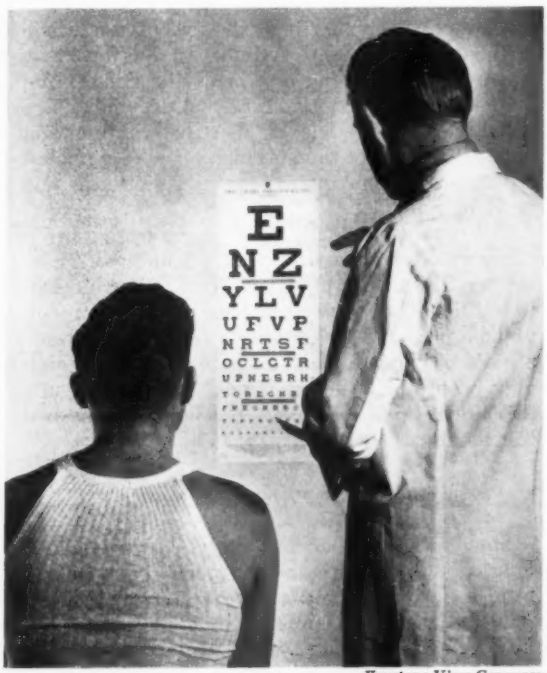
Last of the visual difficulties correctable by eyeglasses to be discussed here are the phorias. As man is blessed with binocular stereoscopic vision, he normally views objects with both eyes simultaneously. Therefore, when nearby objects are visualized, the eyes must rotate in their sockets toward the nose, causing the line of vision to converge. This converging movement of the eyeballs, called "adduction," is effected by the internal recti muscles. In some individuals, the eyes fail to converge sufficiently when nearby objects are viewed. This condition is called "exophoria." Exophoria may be offset by spectacle lenses in the form of wedges, with the bases of the wedges toward the nose. Sometimes the two eyes tend to converge too much; this trouble is called "esophoria." Esophoria is remedied by use of wedge lenses with the bases outward towards the sides of the face.

A third condition involving relative movements of the eyeballs is vertical phoria or "hyperphoria." Both eyes, obviously, must visualize on the same horizontal plane in order to provide a coherent image to the brain. In some individuals, one eye may tend to visualize on a plane diverging upward from that of the other eye. These divergent planes may be

brought together by the use of wedge-shaped lenses, with the base up in one eye, down in the other. It must be stressed that the use of wedge lenses in connection with the phorias merely counteracts the symptoms, does not remedy the underlying defects; medical measures to remedy these defects are available.

Eye Testing

The jargon of eye testing is sufficiently well known that many – perhaps most – people recognize "20/20" as meaning good vision. Equally familiar are the wall charts bearing lines of capital letters of graduated sizes, large at the top and small at the bottom, used to arrive at eye ratings of this sort (Fig. 2). This is the Snellen chart, named after the Netherlander who originated it around 1862. Each line on the Snellen chart is supposed to be legible, at a designated maximum distance, by a person enjoying



Keystone View Company

Fig. 2. Snellen chart, in use, for making objective tests of total visual experience of the patient.

"standard average" vision, with or without eyeglasses. Thus the single large letter at the top should be legible at a distance of 200 feet or less, the smallest line of type at the bottom at a distance of 15 feet or less. Note that the requirement is that the letters be *legible*, not necessarily clear and sharp.

The Snellen chart is designed so that the height of each line of letters is the tangent of five minutes of arc (in other words subtends five minutes of arc) at the distance at which that line should be legible. Thus, the letter supposed to be legible at 200 feet is three and a half inches tall. The letters rated for legibility at 20 feet are a little less than three-eighths of an inch tall.

The fraction representing the Snellen visual acuity rating consists of a numerator that is the distance in feet between the chart and the eyes, and a denominator that is the designation in feet of the smallest line of type legible at this distance. Since the test is usually conducted at a 20-foot distance, a Snellen rating of 20/20 thus means "standard average" vision. A Snellen rating of 20/40 means that with the chart 20 feet distant, the 20-foot line cannot be read but the 40-foot line can; in other words, the vision is somewhat poorer than "standard average." Similarly a rating of 20/15 would indicate superior vision.

Manifestly the Snellen test is a subjective one; that is, it measures the psychological response to the total visual experience, as recounted by the patient. Furthermore the Snellen test, as usually conducted at a 20-foot distance, does not evaluate near vision, employed for ordinary reading. The Snellen procedure, however, has fundamental usefulness in eye testing. It provides an over-all rating of basic visual acuity. It gives clues to the presence of astigmia, for with this condition certain letters may be confused in a line that otherwise can be read; thus *F* may be mistaken for *P*, or *C* for *O*. The Snellen rating even provides a presumptive forecast of the amount of correction that may be required in eyeglasses, by reference to a table that has been compiled on the basis of accumulated experience (see Table 1). This procedure does not, however, indicate whether the needed correction will be provided by convex, concave, or cylindrical lenses, or combinations thereof.

TABLE 1*

Snellen rating gives presumptive forecast of strength, but not type, of spectacle lenses needed.

Snellen Rating	*Expected Correction* (Diopters)
20/200	2.25 – 2.50
20/120	2.00 – 2.25
20/100	1.75 – 2.00
20/ 80	1.50 – 1.75
20/ 66	1.25 – 1.50
20/ 50	1.00 – 1.25
20/ 40	0.75 – 1.00
20/ 30	0.50 – 0.75
20/ 25	0.25 – 0.50
20/ 20	0.00 – 0.25

* Adapted from — Harold R. Barnes, *Fundamentals of Practical Optometry* (New York: Modern Printing Company, 1948).

The Snellen chart is also useful to detect and measure phorias. If hyperphoria is present, the patient sees each line double. To test for the other phorias, a condition of hyperphoria is artificially created by placing wedge lenses in front of the eyes, with the base up in one eye but down in the other. This causes the patient to see each line of type double. If the duplicate lines of type visualized are in alignment, the patient is free of both exophoria and esophoria. If the line seen by the left eye extends to the left of the one seen by the right eye, exophoria is present.

The reverse relationship indicates that the patient is afflicted with esophoria.

Finally, the Snellen chart is a means for the fitting of spectacles by trial and error, using various lenses and various combinations in a trial frame. Such a trial and error procedure is usually a final step in any eyeglass fitting routine.

A variation of the Snellen test may be used to assess near vision. Near vision reflects not only the basic visual acuity as measured by the Snellen chart at a distance of 20 feet, but also, as already shown, the ability of muscles to focus the crystalline lens and to rotate the eyeballs. Test types for this variation of the Snellen procedure are provided on a card with print ranging from a small size less than a millimeter high, rated for legibility with "standard average vision" at four decimeters, to type several times as large rated for legibility at 11 decimeters. Since four decimeters is an average reading distance, a rating of 4/4 by this procedure commonly indicates good near vision.

Observations with the two different types of Snellen charts, considered together, give some presumptive evidence of the type of eye difficulty that may be present. Thus if an individual can read the four decimeter type with the card four decimeters or less distant from the eyes, but has a Snellen rating for distance vision less than 20/20, he is suspected of being myopic. If the four decimeter line can be read only at distances greater than four decimeters, or not at all, but the distance vision is 20/20 or better, presbyopia is suspected.

Objective Tests

The subjective tests just described manifestly are affected by any psychological quirks that influence the responses of the person being examined. Furthermore, since they involve the reading of test types, they are useless with those who cannot read, such as illiterates, imbeciles, or very young children. But fortunately there are objective procedures for measuring light refraction by the eye that require little co-operation from the patient other than sitting still. Although used alone for individuals who cannot read, the objective tests normally are used in conjunction with subjective tests when fitting eyeglasses to literate individuals. The principal instruments for objective determination of visual acuity of the eye are two in number; the retinoscope (also called skiascope) and the keratometer (also known as the ophthalmometer).

The retinoscope is a small instrument held in the hand of the examiner, through which he peers into the eye of the patient. Broadly speaking, the retinoscope measures the angle of emergence from the eye, of light reflected from the retina. The procedure for using this instrument – much too complex to be entered into here – indicates directly whether an eye is normal, nearsighted, or farsighted. By means of small trial lenses arranged in a rotating disc within the instrument so that the examiner may try various ones in front of the eye, the retinoscope also enables a direct estimate of the strength of lens needed to correct whatever hyperopia or myopia may be present.

The keratometer is used in somewhat the same way, but measures the curvatures of the forward surface of the cornea, by means of an image reflected from this surface. This instrument is useful for the detection and measurement of astigmia, since the cornea is the chief site of this defect. The keratometer may also be used to measure the contours of the cornea for the purpose of fitting contact lenses.

It is of passing interest to note that the pinhole may be employed as a tool for eye testing. As the reader is doubtless aware, a pinhole will act as a lens; indeed may be used in lieu of the lens in a camera. A pinhole camera is always in focus, because a pinhole lens has unlimited depth of focus. Similar curious versatility applies to pinholes used in eye testing. For when placed in front of the eye, a pinhole will offset nearsightedness, farsightedness, astigmia, or presbyopia. Hence its utility. If the Snellen procedure reveals substandard vision, the test may be repeated with a pinhole in front of the eye. If the pinhole does not improve the rating, it is probable that the difficulty arises from defects elsewhere than in the optical apparatus of the eye (as for example in the central nervous system). In this event, eyeglasses can do nothing to remedy the defect. By the same token a prescription for eyeglasses may be evaluated by using the Snellen chart with and without a pinhole in front of the spectacles. If the pinhole improves vision appreciably, the prescription is not as good as it might be.

The pinholes actually used in eye testing are precisely made, with sharp edges, 1.3 millimeters in diameter. The reader may, however, amuse himself by trying the effects described above with a homemade pinhole prepared by pushing a common pin through a piece of paper. Indeed such an improvised pinhole may be useful in an emergency to someone utterly dependent upon eyeglasses, but who has smashed or lost them.

Those Trombone Eyes

Since presbyopia affects nearly everyone who lives long enough, it merits a few special comments. The term is derived from *presbys*, meaning "old"; thus is reflected the usual onset of the condition in middle life. In our American way of using humor to cope with human frailties, presbyopia is the butt of many jokes, along with obesity, male baldness, and other hazards of middle age. Thus presbyopia is sometimes called "trombone eyes," because the focusing motions with reading matter held at extended arm's length look like the playing movements of a trombone performer.

One victim of presbyopia the writer knows, insists there is nothing wrong with his eyes; it is just that his arm is not long enough. As much solid fact as humor lies in this quip. Since reading matter is usually held with the elbow at right angles, an individual's normal reading distance is about the same as the distance from his shoulder to his elbow. Thus a person with short arms indeed has an abbreviated reading distance, and may become aware of presbyopia earlier in his life than an individual with arms of average or longer length.

A classic situation where one may first realize that presbyopia has descended upon him is the making of a telephone call from a pay station. First, the fine print of telephone directories combines with the dim illumination afforded by the small bulb in the standard telephone directory lamp, to make the looking up of the number difficult. (Dim light exaggerates presbyopia because the irises of the eyes open wide, thus diminishing depth of focus.) Having mightily strained his poor presbyopic eyes to look up the number, the victim now enters a dimly lit booth. The numbers on a telephone dial are quite large, but the narrow confines of the booth bring the dial so near to the eyes that the presbyopic individual is usually unable to see them without the aid of eyeglasses.

One index of the general prevalence of presbyopia among people past middle life may be noted at scientific meetings, or other conventions, where papers are read from a rostrum. Unless speakers in middle or later years are equipped with bifocals, they are apt to fall into one of two classes; the "putters on" of glasses, or else the "takers off." The "putters on" are the myopic individuals whose presbyopia makes it impossible for them to see their manuscript while wearing the concave lenses of their distance spectacles. They read without glasses, then put the glasses on when looking up, in order to see their audience.

The "takers off" are those with simple presbyopia, or possibly with hyperopia as well. They need to wear spectacles to read their manuscripts. But when they glance up at their audience they find that everything blurs; so off come the spectacles.

It is true, manifestly, that some people enjoy long lives without ever developing presbyopia. This frailty, like all characteristics of living things, shows a wide range of variation.† In general people with hyperopia develop presbyopia relatively early in life; myopic individuals relatively later. Mild hyperopia may become apparent only when presbyopia begins to develop; then correction of the hyperopia may defer the need for eyeglasses to counteract the presbyopia.

As indicated, no absolutely fixed relationship between age and presbyopia exists. Nevertheless average values, based on observations of many people, have been set down in useful tables. Table 2, one of these, demonstrates an interesting fundamental fact about presbyopia. Continuously throughout life, the point that may be clearly visualized recedes further and further from the eyes. Ordinarily this change does not, however, become manifest until middle age because then the rate of change accelerates somewhat, and because then for the first time focusing difficulty is experienced at ordinary reading distances.

Another one of these tables of average values, Table 3, is useful to the eye examiner in making a presumptive guess at the strength of convex lens apt to be needed to overcome presbyopia, on the basis of the patient's age. Using this value as a starting point, he can then determine the exact value by empirical tests, as will be described in a moment.

From Table 3 it is also reassuring to note that there is a limit, plus 2.5 diopters, to the correction for presbyopia needed on the average, even at advanced age. This reassurance may be helpful to middle-aged people who have been dismayed by the speed at which their presbyopia is progressing, and the consequent frequency with which they need to have their eyeglass prescription changed. Incidentally Table 1 shows that 2.5 diopters is also about the limit of total lens correction that is apt to be required, even with low visual acuity.

When a person with presbyopia is enabled to read with lenses no stronger than about one diopter, he usually can visualize distance objects clearly enough through these glasses. If any stronger convex lens than this is used, however, a state of artificial myopia is created. Hence when the individual looks up from his reading and glances across the room, everything blurs. He then joins the ranks of the "takers off," snatching off his spectacles whenever he glances up from his reading or desk work.

†Frederic W. Nordsiek, "The Mathematics of Life," The Technology Review, 50:313 (April, 1948).

TABLE 2*

Although presbyopia only appears in middle age, it reflects a change continuous throughout life.

Age	*Nearest Point Visualized Clearly* (Centimeters)
10	7
15	8
20	10
25	12
30	14
35	18
40	22
45	28
50	40
55	60
60	100
65	133
70	400
75	infinity

* Adapted from — Harold R. Barnes, *Fundamentals of Practical Optometry* (New York: Modern Printing Company, 1948).

TABLE 3*

Presbyopia appears in middle life, and increases slowly with age.

Age	*Average Convex Lens for Reading* (Diopters)
40	0.25
45	0.75
50	1.25
55	1.62
60	2.00
65	2.12
70	2.37
75	2.50

* Adapted from — Harold R. Barnes, *Fundamentals of Practical Optometry* (New York: Modern Printing Company, 1948).

This difficulty is circumvented by exploiting the fact that when reading, one normally directs the glance downward. This makes possible the use of bifocal lenses. Such lenses have an upper section designed for distance vision, or even "plano" if no correction for distance vision is required. Bifocals have a lower segment, containing additional convex spherical correction. The wearer looks through these segments while reading or doing similar close work. A corresponding arrangement for people who need no correction for distance vision are the half spectacles or "Foxy Grandpa" glasses, having semicircular lenses covering only the lower part of the eye; the wearer peers over these to look at distant objects.

The more powerful convex lenses for presbyopia correction become, the less the depth of focus. Therefore, the wearer of bifocals may reach a point where he can see objects at reading distance through the segment, and distant objects through the top of the lens; but where he cannot see clearly at intermediate distances. This fact has led to the development of *trifocal* spectacles, having a segment divided into upper and lower sections. The lower section contains the full correction for reading distances, the upper section less, enabling the visualization of middle distances. The upper part of the lens, as always, is designed for distance vision.

Having arrived at an estimate of the type of lens (convex, concave, or cylindrical) and the strength (focal length) required, through a combination of the subjective and objective tests described, applied to each eye separately with the other eye occluded, the examiner then proceeds to make a final decision by trial and error. He uses a trial frame adjustable to the patient's features, to hold trial lenses. Such trial lenses come in sets with the full range of convex, concave, and cylindrical. Confronting the patient with a Snellen chart, the examiner (again testing one eye at a time) tries spherical lenses of various strengths around the value his previous observations have suggested. If astigmia is present, the examiner not only tries cylindrical lenses of assorted focal lengths, but also rotates the axis of the cylinder into various positions. During these trials the effectiveness of the lenses is measured by the patient's ability to read the chart.

Thus the examiner arrives at an empirically proved lens to produce optimal vision for each eye. If the patient is in the age group subject to presbyopia, the examiner first decides upon lenses for distance vision, then determines how much additional concave lens is needed to enable clear vision at reading distances.

The examiner next sets down his conclusions in a prescription. The unit used is the diopter, defined as a focal length of one meter in air. Two diopters signifies a focal length of one-half meter. Convex lenses are denoted by the arithmetic plus sign; concave lenses by the minus sign. One-quarter of a diopter is the smallest increment ordinarily employed. Thus +0.25 designates a convex lens of one-quarter diopter, or having a focal length of four meters.

Cylindrical lenses are similarly designated in diopters, but also by the axis on which the cylinder lies. The range of this axis, arbitrarily, begins at 0 degree at the left of the face, signifying a horizontal axis. A vertical axis is designated 90 degrees. The limit of the range is 180 degrees, which, like 0 degree, indicates a horizontal axis. No values larger than 180 degrees are needed because, for example, 270 degrees would again indicate a vertical axis and therefore be the same as 90 degrees.

Ordinarily 5 degrees or 10 degrees is the smallest increment used in prescribing axes of cylindrical lenses. By convention, cylindrical lenses are prescribed as convex or plus. This custom is practical because any minus cylindrical lens is equivalent to the same strength as a plus lens, with the axis rotated 90 degrees. Thus "cylinder 1.00 axis 30" means a one diopter cylindrical lens with the axis of the cylinder slanting from the upper left to the lower right, at an angle of 30 degrees from the horizontal.

Fig. 3 shows a typical prescription for eyeglasses. As in most prescriptions, Latin is employed. This practice, established in the healing arts centuries ago primarily to obfuscate the patient, is now continued perhaps mainly through custom. "O.D." means *oculus dexter*, or right eye. "O.S." means *oculus sinister*, or

	Sphere	*Cylinder*	*Axis*
O.D.	+1.00	0.75	60
O.S.	+0.75	———	———

Add +1.00 O.U. for near

Fig. 3. A typical prescription for eyeglasses. This individual, like many adults, suffers from hyperopia, astigmia, and presbyopia.

left eye. "O.U." means *oculi uterque*, or both eyes. This particular prescription calls for 1.00 diopter convex spherical lens for the right eye, 0.75 diopter convex spherical lens for the left eye. Thus this individual has mild hyperopia, somewhat more in the right eye than in the left.

The prescription also calls for a cylindrical correction of 0.75 diopter, positioned at the 60-degree axis, in the right eye; this to offset astigmia.

The bottom line of the prescription means that an additional one diopter of convex spherical lens, for both eyes, is needed to enable the patient to see clearly for reading; this takes care of presbyopia.

The patient now carries his prescription to that member of the eyeglass hierarchy known as the optician. The optician makes one final necessary measurement; the distance between the pupils of the two eyes. This measurement is taken with a ruler held in front of the patient's eyes. Two variations are noted; one with the eyes in the distance vision position or looking straight ahead, the other with the eyes in reading position – adducted or rotated inward.

The patient next selects eyeglass frames, according to his own ideas of style, and according to the optician's dicta concerning distance between the pupils, size and proportions of the face and head, breadth and contours of the bridge of the nose, and relative location of the ears where the temples of the eyeglasses rest. Also involved is a choice of lens shape.

(*Concluded on page 214*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Webster Professorship

ROBERT A. RAMEY, JR., manager of the Magnetic Development Section of the Materials Engineering Department of the Westinghouse Electric Corporation (Pittsburgh), has been appointed Visiting Webster Professor of Electrical Engineering at the Institute for the second semester of the current academic year. The Webster Chair of Electrical Engineering at M.I.T. was established in 1952 under a grant of $400,000 from the Edwin Sibley Webster Foundation in memory of the late Mr. Webster, one of the Institute's most distinguished Alumni. Dr. Ramey will participate in the development of teaching and research in the new area of solid state nonlinear devices and their applications to power modulators.

Prior to his appointment with Westinghouse in 1952, Dr. Ramey served as head of the Electromagnetic Components Section of the Naval Research Laboratory. While on this assignment he created a new theory of magnetic amplifiers and invented several new circuits.

At Westinghouse he has supervised and participated in research on machine tool, elevator and manufacturing process control; metering and telemetering; direct and alternating power conversion; and static devices for operation in the megacycle range.

M.I.T. Photo

Robert A. Ramey, Jr.
Visiting Webster Professor

Beneficent Uses of Science

THE third Midwest Regional Conference, the theme of which will be the "Beneficent Uses of Science," will be held on Saturday, February 26, 1955, at the Mid Day Club which is located in the Union Commerce Building, Cleveland, Ohio. The convocation will be an all-day event. It is scheduled to start at ten o'clock in the morning, and will be concluded with a dinner in the evening at which James R. Killian, Jr., '26, President of the Institute, will speak.

As has been true with previous conferences in other cities, Alumni and friends of the Institute in the Cleveland area will be given opportunity to hear reports of progress on science from a group of leading scientists who will travel from M.I.T. in Cambridge to Cleveland, especially for this conference. One of the four Faculty members from the Institute who will participate actively on the program is Professor Gordon S. Brown, '31, Head of the Department of Electrical Engineering, who will speak on automation. From the same Department will come John G. Trump, '33, Professor of Electrical Engineering, who will discuss high energy particles and radiation in medicine and industry. The future uses of nuclear energy is the topic to be presented by Manson Benedict, '32, Professor of Nuclear Engineering. John E. Arnold, '40, Associate Professor of Mechanical Engineering, will speak on creative engineering. Richard S. Morse, '33, of the National Research Corporation in Cambridge, will discuss "This Business of Research."

Further information on the Cleveland Conference may be obtained by addressing inquiries to William C. Sessions, '26, whose address is: Bosworth, Sessions, Herrstrom, and Williams, 727 National City Bank Building, Cleveland 14, Ohio.

Hockey Game Opens Ice Arena

A HOCKEY game between undergraduates and Technology Alumni will be a feature event during the week end of February 19 and 20 when an artificial ice arena will be dedicated at the Institute. The new ice-skating area, west of Massachusetts Avenue, is adjacent to the Kresge Auditorium now nearing completion, and will use the refrigerating equipment of the auditorium for producing artificial ice. This new athletic facility will be reserved for a skating party for Alumni, their friends, and invited guests from 4:00 to 6:00 P.M. on Saturday, February 19.

Dedication exercises will be held at 2:45 P.M. on Sunday, February 20, at which time Robert M. Kimball, '33, Secretary of the Institute, will speak. The Alumni-M.I.T. Varsity game will follow these exercises. In the evening, a dinner for those interested in hockey (Technology Alumni, their wives, and guests) will be held at 7:00 P.M. at the Faculty Club.

Charles M. Curl: 1880-1954

CHARLES M. CURL, '07, Assistant Professor of Drawing and Descriptive Geometry, Emeritus, who served on the Institute Faculty for 25 years before retiring in 1945, died on October 8, 1954. He was 74 years old.

Professor Curl was born in Antrim, N.H., and received the degree of bachelor of science at M.I.T. He taught at the University of Maine before joining the Institute staff in 1920 as instructor in the Division of Drawing, which later became the Section of Graphics. Professor Curl retired in 1945 as assistant professor of drawing and descriptive geometry, emeritus, and as lecturer in the Section of Graphics.

M.I.T. Photo

The M.I.T. Nautical Association Sailing Team for the fall season and the trophies won by the Association during the past year.

Front row, left to right: Charles S. Robertson,Jr., '55 (Erwin H. Schell Trophy), J. Nicholas Newman, '56 (Sir Thomas Lipton Trophy), Commodore Alain J. de Berc, '55 (holding the National Intercollegiate Morss Bowl and the Brown University Trophy in front), John F. Wing, '55 (C. Sherman Hoyt Trophy), Paul D. Goldan, '55 (Danmark Trophy).

Back row, left to right: Silvester Pomponi, '57, George F. Barry, '56, Hamilton W. Stiles, Jr., '57, Ernest B. Blake, '55 (Harvard versus Technology Trophy), John E. Marsland, Jr., '57, George F. Baker, '56, Richard I. Mateles, '56 (Oberg Trophy), James L. Simmons, '55 (Nevins Trophy).

Not shown is the Potomac Frostbite Trophy won by the Nautical Association on December 4 and 5, 1954.

Senior Named Rhodes Scholar

WGILBERT STRANG (the son of Mr. and Mrs. William D. Strang of St. Louis, Mo.), a top-ranking senior at M.I.T., was recently named a Rhodes scholar-elect for two years' advanced study at the University of Oxford, England. He is one of 32 winners in this year's American competition as announced by the American Secretary of the Rhodes Scholarships.

Enrolled in the Institute's Mathematics Department, Mr. Strang is completing in three years the usual four-year undergraduate course of studies. He was president and valedictorian of the Class of 1952 at The Principia, and at M.I.T. has been active as a member of the varsity tennis team and the Mathematics Society and as an officer in Theta Delta Chi Fraternity and the Christian Science Organization.

The selection of Rhodes Scholars is made in three stages. The candidate's first step is to gain the nomination of his college or university to stand as its representative in the competition. He then meets before a State Committee of Selection which has the option of sending two state nominees forward to a District Committee. The District Committee, in turn, is charged with the responsibility of choosing up to four Rhodes scholars from a group of nominees representing six states. The final selection is based on a preliminary examination of credentials, followed by the candidate's appearance before the Committee for informal personal interview.

The Rhodes Scholarship award was instituted in 1903 by the will of Cecil John Rhodes, whose hope was that international educational exchange would build increased international understanding and eventually foster world peace.

Catalytic Conclave

WHEN members of the Visiting Committee on the Department of Chemical Engineering* met at the Institute on May 7, 1954, for their annual review of matters relating to Course X, they found a long agenda to be acted upon. Deliberations occupied a full day and the Committee's report, comprising about a dozen mimeographed pages, is much too long to appear in full in the pages of The Review. The Committee's report was presented to the Corporation on June 11, to the Executive Committee on September 17, and was released for publication in The Review, in condensed form, on September 29.

Although many topics were discussed, for the most part the deliberations of the Visiting Committee were concerned with three major topics: (1) proper selection of students and members of the teaching staff for the Department of Chemical Engineering; (2) the role of Nuclear Engineering in the Department's activities; and (3) current problems relating to the Department's summer study programs in its Practice Schools.

Fortunately there is little difficulty in attracting outstanding men from the Graduate School for careers in teaching. The Department feels that it has, therefore, a continuing and good source of future staff members, although experience shows that it is difficult to get outstanding men to return to teaching positions after they have been in industry for several years.

(*Continued on page 200*)

* Members of this Committee for 1953–1954 were: Charles A. Thomas, '24, chairman, Bradley Dewey, '09, William M. Stratford, '21, William S. Brackett, '23, James H. Doolittle, '24, Robert B. Semple, '32, J. Peter Grace,Jr., and Anthony Nerad.

BUSINESS IN MOTION

To our Colleagues in American Business . . .

This is called a rack. It is fastened to electric light poles to hold wires from pole to pole, and from pole to house. Perhaps you may have noticed racks on poles, but unless your electric company has recently replaced them on the lines in your vicinity you have not seen anything quite like this. It is made of aluminum, instead of galvanized steel, and is assembled almost entirely of extruded shapes.

Naturally you will think that aluminum was chosen in order to save weight, and as a matter of fact, lightness plus strength is a factor. The aluminum rack is five to six pounds lighter, and that is appreciated by the linemen who have to put the rack on the pole after they have climbed it. However, lightness is not the main consideration. Long life is the big advantage. Modern methods of treating poles with preservatives make it reasonable to assume that a pole will last for 50 to 60 years. Now for the first time there is a rack or bracket, as it is sometimes called, that should outlast the pole. As soon as aluminum is exposed to the air, a thin film of oxide forms, and this is a protection against further action by air and rain. As for price, the aluminum rack costs a little more, but this is compensated, many times over, by the increased years of service.

There are some interesting features of design that are worth noting. The extruded shape that forms the base of the rack is adequately ribbed for strength, and in addition, provides a channel into which the arms are slid after having been notched and bent at right angles. The channel and the arms together take the pull of the wires; the rivets are used just for positioning. Incidentally, the rack has to withstand a total pull of 6,000 pounds. The arms are formed with a slight longitudinal camber or bow and have rounded edges, because linemen pull the wires across them, and the camber and edges protect the insulation from damage. The rod on which the insulators are threaded is extruded aluminum. One final detail, which is not easy to see in the drawing; the bottoms of the base are toothed, to hold to the pole better.

Revere takes especial satisfaction in this new and superior rack, because the Technical Advisory Service, the Mill, and the customer worked so closely together. There was a joint attack on the problem of developing a product that would not only be better, but could be assembled simply and economically. Suppliers to industry are not only well informed regarding their materials, but glad to cooperate with customers and prospects on matters concerning specification and fabrication. Revere suggests that you call upon your suppliers not only to fill orders, but to place their skill and knowledge at the disposal of your designers and production people.

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THE INSTITUTE GAZETTE

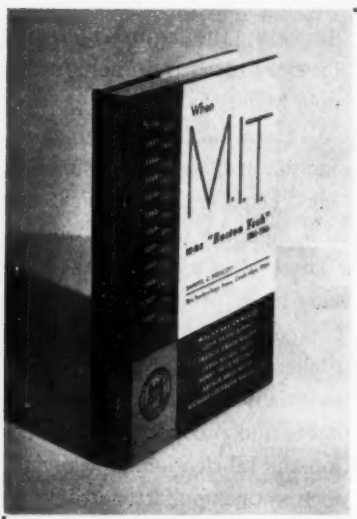
(*Continued from page 198*)

Professor Edwin R. Gilliland, '33, pointed out the importance of securing students of proper qualifications in the Department. The Department has practically nothing to do with selection of undergraduates, but the selection of graduate students is entirely the responsibility of the Department. The cost of graduate study, and the financial support which graduate students are able to obtain while pursuing advanced degrees, have a bearing on the applications which the Department receives for advanced study. Although the Department of Chemical Engineering is able to provide fellowships on a basis favorable with that offered by other departments at the Institute, it faces competition from other colleges for first-rate graduate students. The Department would be in a more favorable competitive position with increased fellowship funds; these are the result of offers from industry rather than solicitation by the Department, since students who accept such fellowships are under no obligations to join the firm which provides the fellowship. One of the Institute's major responsibilities is to uncover new fields for research. Opposition was expressed at the idea of obtaining government money in support of specific research problems merely because such funds might be available.

In discussing the Institute's course in nuclear engineering, Professor Manson Benedict, '32, emphasized the aim of providing broad education in general disciplines (such as physics, mechanical engineering, or chemical engineering) for students who wished to follow the more specialized nuclear field. The curriculum for students enrolled in nuclear engineering is intentionally made broad, because men trained in diverse disciplines must work together in the new field. The Institute's courses deal with unclassified topics, but those students who can be cleared are encouraged to participate in summer projects at the Oak Ridge Practice School, where classified research is undertaken.

The third major point of discussion was related to the Chemical Engineering Practice School and the Oak Ridge Practice School. For many years the Chemical Engineering Practice School has provided ideal training and plant experience for students prior to their industrial work; the School is especially useful for students taking employment with companies not large enough to do their own professional training. The Oak Ridge Practice School was organized in 1948 with the expectation that students from other departments at the Institute would make extensive use of its facilities. Of 94 graduates who took training at Oak Ridge, 73 were chemical engineers, 17 were mechanical engineers, and only 4 came from other departments. The diversion of chemical engineering graduates to the Oak Ridge Practice School has

(*Concluded on page 202*)



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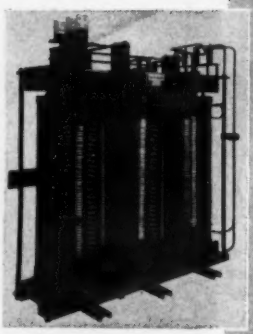

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THE INSTITUTE GAZETTE

(*Concluded from page 200*)

caused a significant reduction in enrollment of the Chemical Engineering Practice School. The imminence of military service, the need for some students to begin their professional earnings, and the industrial practice of recruiting students for summer work with good pay further restrict potential recruits for the Chemical Engineering Practice School. It appears that the Department of Chemical Engineering does not train sufficient students to utilize fully the facilities of both Practice Schools. It was the feeling of the Visiting Committee, however, that the Practice School fills an excellent and desirable function, and that it should be strongly supported.

Under the Institute's integrated Humanities program, students are allowed greater freedom in selecting electives. It is felt desirable for the Department to offer two professional electives for seniors: (1) kinetics and catalysis; and (2) a course synthesizing a number of undergraduate courses. The second course has already been offered and has been well received.

ENGINEERS IN POLITICS

(*Continued from page 190*)

fixed, data, I trust that he may continue to be an important force for political betterment in his community.

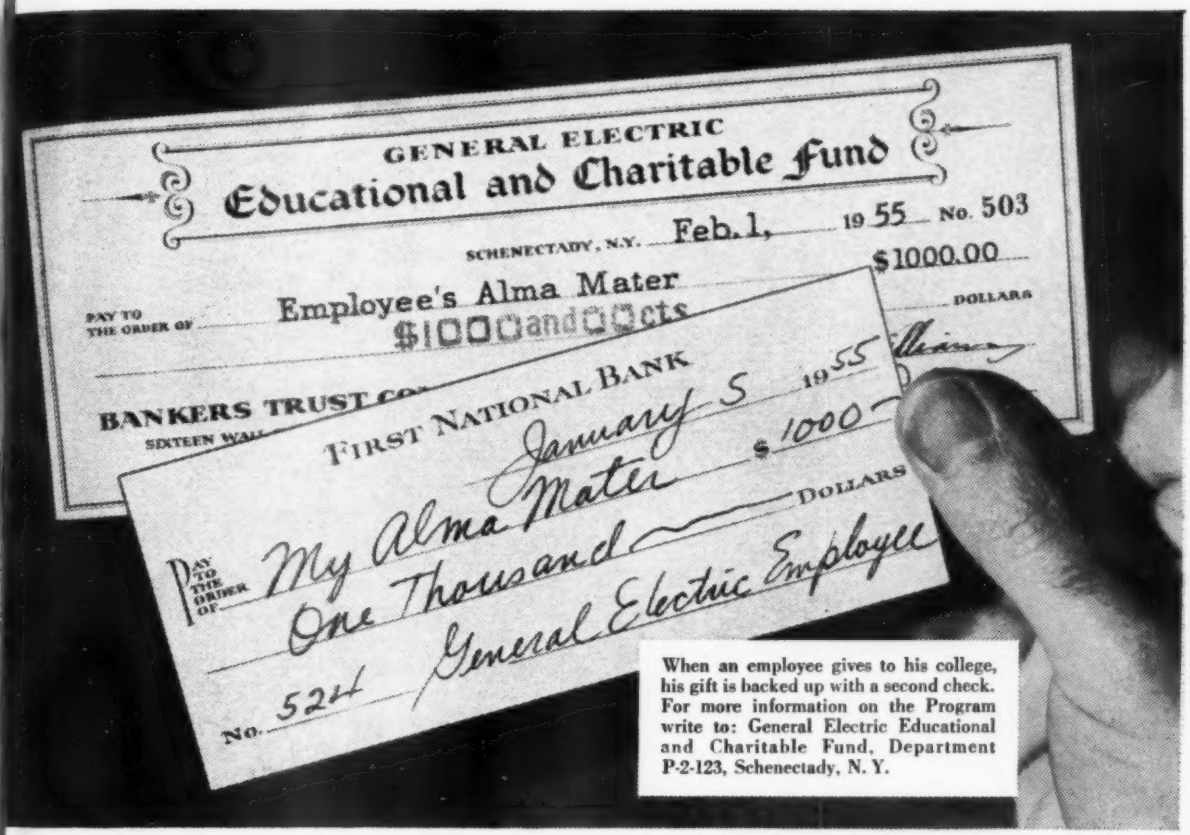
It will be observed that, if our hopes were to be realized, nearly every engineer would be expected to give some time to active political work, mostly with limited responsibilities which would not greatly interfere with his professional work. The holding of the more important political positions (such as that of mayor of a city, or membership in the United States Congress, or in a state legislature) present greater difficulties and might easily consume so much time as to interfere seriously with an engineer's professional duties. These policy-forming political positions are so important, however, and the percentage of engineers in them at present is so close to zero, that every possible effort should be made to encourage engineers to seek to fill them.

Large engineering firms might well assist, as legal firms often now do, in making it easier for some of their younger members to hold time-consuming public office. An older engineer who has been successful enough financially to provide reasonably for his family needs might well retire from active engineering work to devote the rest of his life to public service. Although not very frequently followed, a notable example of the latter procedure is that of former President Herbert Hoover. Another great engineer who followed this example and retired entirely from his former important Canadian engineering work, to devote his outstanding talents to public service for the

(*Continued on page 204*)

GENERAL ELECTRIC EDUCATIONAL AND CHARITABLE FUND OFFERS:

A new way of giving colleges the financial help they need



When an employee gives to his college, his gift is backed up with a second check. For more information on the Program write to: General Electric Educational and Charitable Fund, Department P-2-123, Schenectady, N. Y.

The G-E Educational Fund announces a plan to match an employee's gifts to his college, up to $1000 in one year.

One out of every two colleges and universities in the U.S. is today operating in the red, and rapidly increasing enrollments mean they face a mounting deficit every year.

To American industry, which depends on healthy schools for its trained man power, the question is, "How can we help—and encourage others to help?"

A "Corporate Alumnus Program" is now announced for 1955 by the Trustees of the General Electric Educational and Charitable Fund. Here is how the plan works:

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ENGINEERS IN POLITICS

(*Continued from page 202*)

past 19 years, is Clarence D. Howe, '07, now Canadian Minister of Trade and Commerce, and Minister of Defence Production.

Now a fellow member of the M.I.T. Corporation, Mr. Howe was also a graduate of the Institute's Course in Civil Engineering when it was headed by that inspiring teacher, the late Professor Swain. Then, as now, the M.I.T. teaching staff included many men of unsurpassed technical abilities who were also devoted to the public service. Professor Swain might well be proud of his pupil, Minister Howe, who has had such a large share in improving the economy of Canada in recent years. This has resulted in the present high valuation of the Canadian dollar among the world's currencies—even higher than the United States dollar.

By their characteristic objective and clear thinking, engineers, in important political positions, could contribute much that is necessary and greatly to be desired for the public good. The fact that most such engineers would be serving at a personal sacrifice, with no selfish interest of financial gain in being re-elected, could be helpful. They would be likely to vote as their better judgment dictated, and not against their own better judgment in order to curry favor and be re-elected.

The technical training of an engineer naturally develops in him habits of exact thought. The correct analysis of various factors which may cause errors and the objective attaining of the truth are essential procedures in solving engineering problems. When an engineer is designing the steel frame for a skyscraper, a length of 20 feet, 6¼ inches for a steel beam means exactly that and nothing less or nothing more. A quarter-of-an-inch error may cause the beam not to fit.

When a lawyer is arguing a case before a jury, however, sometimes success for his client and himself comes from the lawyer's skill in making the worse appear the better. A lawyer must seek to find out the facts of his case, it is true, but in the trial he devotes his efforts to presenting only such an interpretation of the facts as may seem favorable to his client.

I understand fully the adequate reasons for such conduct by lawyers when acting as paid advocates for clients. My objections to the present high percentages

(*Continued on page 206*)

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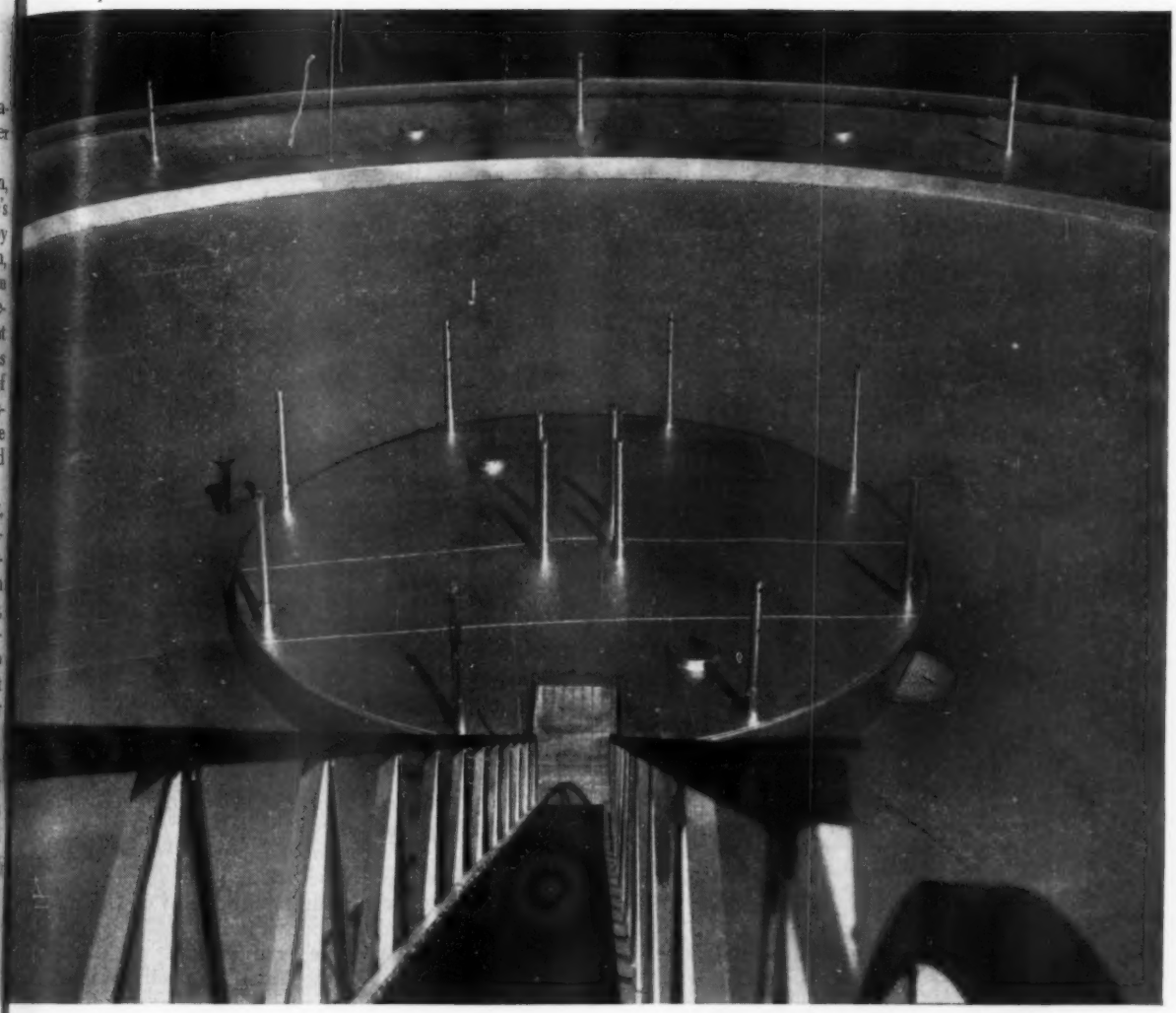

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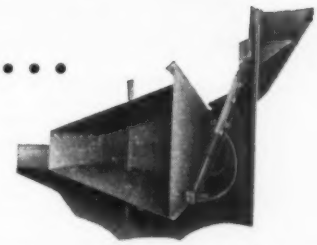

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ENGINEERS IN POLITICS

(Continued from page 204)

of lawyers in our state legislatures and the United States Congress stem largely from the fact that so many lawyer-legislators use the same habits of thought and the same standards in carrying out their legislative duties.

To function properly, representative government requires that, after proper study, men in policy-forming political positions should vote in accord with their honest convictions, and not otherwise as they may be requested by outside, nongovernmental interests, which are too often selfish and opposed to the public good. Throughout our whole country, representative government now suffers greatly from the too frequent and too prominent inclusion – even to the attainment of legislative leadership – of the type of politically subservient lawyer I have described. It will be improved when more engineers, and other men and women, who are not dependent on politics for a livelihood, are willing to seek and serve in policy-forming political positions.

Politics, another name for government, will approach more closely the noble ideals of George Washington, Alexander Hamilton, Thomas Jefferson, and the other great founders of our republic, when more engineers and other constructive-minded Americans are willing to take an active part in politics, not for what they selfishly receive, but for what they can unselfishly give. Let us not forget that, in his youth, George Washington served as an engineer and surveyor in colonial times.

One of the best known business leaders of the United States, Clarence B. Randall (formerly President and now chairman of the Board of Directors of the Inland Steel Company), in the M.I.T. commencement address last June, well said:

"The first duty of the American businessman is not to his company but to his country, because there will be no American system of business as we have known it unless our country continues strong and vital, and measures up to its awesome responsibility in the world. . . . Your job at the beginning is at the community level. That means helping with the schools to which your children will go, it means the church, it means all of the community services, it means entering into political life in the best sense, joining a political party, knowing what political creed you espouse and furthering it in the great American faith.

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Then going on into the more mature positions of leadership. . . ."*

It is our local politicians who usually nominate candidates for the United States Congress, and, as delegates to national conventions, even our candidates for President. Bad politics at a local or state level inevitably leads up to bad politics at the national level. Bad politics at the national level leads to decisions – often of world-wide importance – which are made not in accordance with great principles of truth and justice, but to win domestic elections. Ultimately, the welfare of the United States may be easily jeopardized by winning national elections on a series of dazzling but false issues.

Better politics and better statesmanship, with both brought into accordance with high engineering standards of truth, intelligence, and reason, could produce a better world. Our present international difficulties do not seem to me to have resulted inevitably. The world of 1955 that knows television and many other magnificent engineering achievements should not be a world armed as never before for mass destruction. To seek to determine, and then to eliminate, causes of evils represents a noble challenge to men of good will in all professions, and certainly to engineers.

Conclusion

My appeal is for a greater number of men and women of intelligence and high character to be active in politics. Certainly intelligence and high character are not confined exclusively to engineers, nor do engineers hold a monopoly on virtue. But the education and daily work of engineers are concerned with seeking the exact truth and then working hard to have that exact truth prevail in spite of obstacles. The solution of our many social and political problems today requires men who are willing and able to do just that – determine the truth and then work mightily against all obstacles to have that truth prevail. Men and women of many groups may share alike in the desire to make the world better, but no group can be more effective toward the attainment of that ideal than well-trained engineers. Engineers have helped mightily in raising our standards of living. Their help is needed now to raise our standards of politics.

* Clarence B. Randall, "The Educated Man," The Technology Review, **56**:461 (July, 1954).

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CHALLENGE FACING THE UNITED STATES

(*Continued from page 185*)

Finally Stalin's successors confront the Russian peoples themselves, anxious for peace, anxious for material advance, anxious to have the burden of chronic fear lifted from them. These popular ambitions the Kremlin recognizes, but cannot satisfy without changes in domestic rule and foreign policy it is still unprepared to make.

Stalin's successors have clearly been aware of the cost and the dilemmas Stalin's heritage has imposed upon them. And the symptoms of this awareness have impressed many European observers of the Soviet scene, notably Sir Winston Churchill, who spoke of them on his trip to Washington in the summer of 1954.

It is certainly heartening to observe that history has not stopped in Russia; and to be able to demonstrate with precision that monolithic totalitarianism creates grave long-run problems and dilemmas by the very techniques which impart a surface of implacable strength in the short run. Our national policy should seek to exploit and to consolidate any substantive possibilities for easing tensions which may result from internal changes in the Soviet Union.

There would be grave danger, however, in assuming that these recent symptoms of change in the Soviet Union automatically will yield a solution to world-wide tensions. There are no signs whatsoever that the changes wrought by Stalin's successors are as yet more than superficial.

They have not in fact decreased the allocation of resources to military purposes and heavy industry. They have not in fact altered the police techniques of control over the Russian peoples. They maintain an imprisoned agriculture, embracing 50 per cent of the population. The modifications in the forced labor system have thus far been minor. The realities of Moscow's total control by armed force over the satellites remain beneath the surface of new policy gestures.

Moscow and Peking talk much of increased East-West trade; but there is not the slightest evidence that they are prepared to restructure their economies in order to expand such trade significantly, and without such drastic reorganization they simply do not have the capacity to trade on a substantially increased scale with the rest of the world.

Communist China is a somewhat different case, although the same broad conclusions hold. The men who now rule the China mainland are confident, ruthless, ambitious for indefinite expansion of power and prestige in Asia. They are in a mood nearer to Stalin of the 1930's than to the uneasy middle-aged bureaucrats who now rule in Moscow.

The system of centralized power that Peking has clamped on the Chinese people guarantees intimate control in the short run. But the Chinese Communists confront two great problems. First, it is doubtful that the Soviet technique of industrialization after 1929, based as it was on a rich surplus agriculture and an industrial heritage left from

(*Continued on page 210*)

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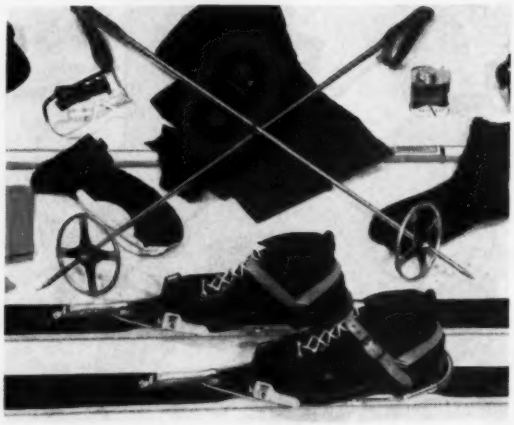

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CHALLENGE FACING THE UNITED STATES

(*Continued from page 208*)

czarist times, can produce the results the Chinese Communists seek on the Asian scene. Communist techniques in Russia caused a 20 per cent fall in agricultural output in the First Soviet Five-Year Plan. This resulted in millions of deaths; but Russia's natural food surplus mitigated the crisis. Such an outcome in China would constitute a human disaster which would shake the control system erected by Peking and damage, if not destroy, the image of leadership the Chinese Communists seek to project out on Asia.

Whether or not a disaster of this magnitude comes about in China in the next decade it is clear that the regime has succeeded in alienating the 80 per cent or so of the Chinese people who are peasants; and it has damaged the incentive to produce from the soil on which all else depends in China.

Second, the Chinese Communists are caught up inextricably in the fate of Asia. They are not isolated, like the Soviet Union after 1919. They must either make good their pretensions as the ideological model for Asia, and its major power, or they must fail.

Here is the Free World's challenge and opportunity in Asia. There is no reason why a united Free World cannot produce more substantial material and human progress in Free Asia over the coming years than the Communists can in China. Such an outcome could be expected to have profound indirect consequences on the China mainland, on Sino-Soviet relations, and on the world-wide status of Communism as an ideology.

Conclusion

In short, any responsible analysis of the situation within the Communist bloc leads to this conclusion: a vigorous and united Free World has the material and spiritual resources to frustrate Communism's menace and outstrip its pretensions as a system for solving the problems of organized society in this century.

These reflections, then, are basically optimistic. The areas for action are open to us on this side of the Iron and Bamboo Curtains. We have the

(*Concluded on page 212*)

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CHALLENGE FACING THE UNITED STATES

(Concluded from page 210)

resources, the talents, and the heritage of ideas and idealism necessary for the task. The challenge facing the United States can be met with success.

The proposed lines of action carry, of course, a price tag – a substantial price tag: some several billions of dollars more each year spent and invested in the Free World and at home than we now budget for. Extra material resources alone emphatically cannot do the job; but they are probably necessary. Can we afford such substantial additional outlays? Of course we can. Our economy normally increases its capacity to produce by about 14 billion dollars each year. At the moment, we have an unused margin of capacity of about 30 billion dollars. If this regular margin, plus this backlog, is not enough – and it is almost certainly sufficient to meet the foreseeable challenge – we have larger margins of surplus consumption to fall back on than any society in the world. If we fail to meet the challenge, it will not be because we lacked the resources both to do the job and to maintain our high standard of welfare.

Do we have the will to do this job? Here each man must speak from his own sense of the nation and from private faith. I should merely say that there is nothing in our history out of the long or recent past to suggest that, when the facts are laid before the American people and vigorous leadership offered, we will fail to respond. I profoundly believe once the trend of events is made clear, that it is not in the American temperament to accept the slow, only momentarily comfortable defeat the enemy plans for us. Our country was born as a symbol to the world of national independence and freedom ordered by individual consent. We are not yet ready to retire from a field where independence and freedom are the issues of combat.

Victory will not come without sustained effort. It will not arise from complacency, peevishness, or brooding over past errors. It will not come cheaply. It will not be hastened by attempts at short cuts or by partisan slogans. It requires a united America maintaining a solid creative effort – military, political, and economic – for decades if necessary.

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THROUGH A GLASS, DARKLY

(*Concluded from page 196*)

The optician is now ready to make up the glasses. From an optical concern he obtains the requisite "blanks" – large lenses with finished ground and polished surfaces, but with rough edges. Such blanks come in the full range of convex and concave lenses, with or without any cylindrical correction, all in the customary 0.25 diopter increments. The axis of the cylinder in the blanks is of no import, as it is set when the margins of the lens are cut.

Now the optician needs merely to cut the periphery of the blanks so that they fit the frame selected, and so that the centers of the lenses, and the axes of the cylinders, if any, are properly positioned. This cutting is done on a simple compact automatic machine. The optician fastens the blank in this machine, positioning the center of the lens according to his measurement of interpupillary distance, and positioning the axis of the cylinder, if present, according to the prescription. Into the guide mechanism of the machine he inserts a template of the size and shape of lens required for the frame. He turns the machine on, and soon the lens is finished.

Grinding of the surface of spectacle lenses is ordinarily done locally only when a cylindrical correction is needed in bifocals or trifocals. Such lenses are available as ready-made blanks with all combinations of spherical correction. But since the location of the segment in these lenses determines their position, they cannot be rotated to position spherical correction. Therefore cylinders ordinarily are added by surface grinding in a local optical shop.

Finally the optician needs only insert the lenses into the frame and effect a few minor adjustments of the frame to fit exactly the features of the wearer.

Thus the perfection of modern medical, optometric, optical, and mechanical skills have made the fitting of eyeglasses a precise and effective procedure. But although eyeglasses serve to offset ordinary visual weaknesses, there are many other eye changes – infections, structural degeneration, benign or malignant tumors, opacity of the crystalline lens or cataract, trauma – that require the skilled attention af a medical man. This article has sought to provide an understanding of the technicalities of eyeglasses, that may help the reader co-operate with the professional man who supervises the care of his eyes. Such co-operation is essential to conserve vision, most precious of the human faculties.

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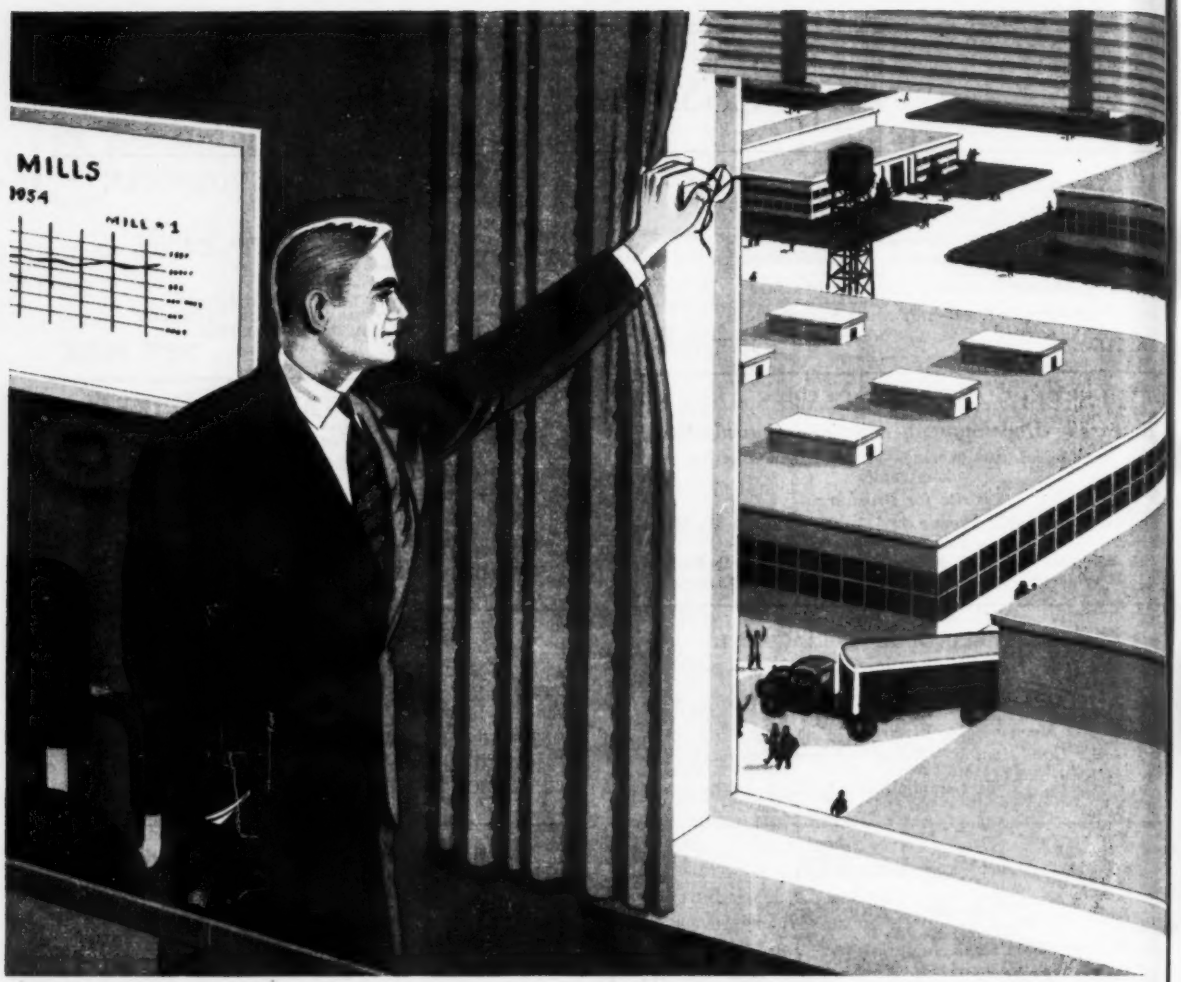

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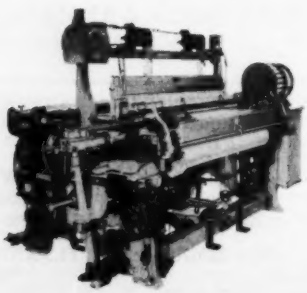

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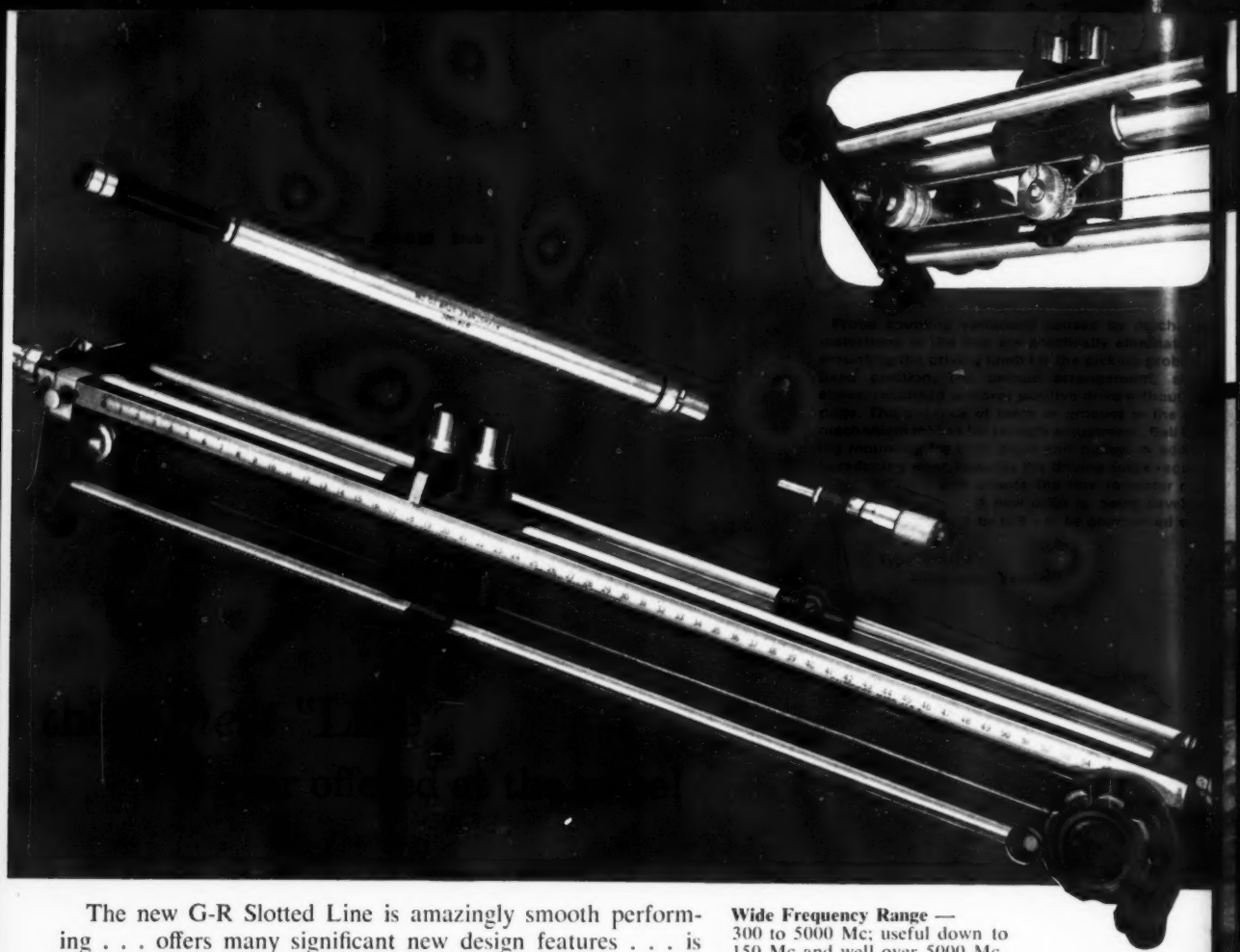

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